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AN EMPIRICAL ANALYSIS OF THE PHYSICAL APTITUDE EXAM AS A PREDICTOR OF PERFORMANCE ON THE PHYSICAL READINESS TEST

by

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June 2000

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ABSTRACT

The Physical Aptitude Exam, administered to candidates in the Naval Academy admissions process to measure physical aptitude, consists of pullups for men or the flexed arm hang for women, a 300-yard shuttle run, a standing longjump, and a kneeling basketball throw. The Physical Readiness Test, administered semi-annually to all naval personnel including midshipmen, consists of modified situps, pushups, and a 1.5-mile run. The purpose of this research is to determine if the Physical Aptitude Exam predicts performance on the Physical Readiness Test. Naval Academy midshipmen data from the classes of 2002 and 2003 are analyzed to determine if the Physical Aptitude Exam, taken sometime during the application process, predicts performance on the Physical Readiness Test taken during the fall semester of the midshipman's plebe year. This study uses logit and linear regression analysis to identify two significant explanatory variables; pullups/flexed arm hang and shuttle run, which predict Physical Readiness Test performance. Recognizing the factors that predict performance on the Physical Readiness Test may not only increase the number of midshipmen who pass the Naval Academy's fitness test, but also identify candidates at risk of failing the Physical Readiness Test when they become midshipmen.

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I. INTRODUCTION

The mission of the United States Naval Academy (USNA) is "To develop midshipmen morally, mentally, and physically, and to imbue them with the highest ideals of duty honor and loyalty in order to provide graduates who are dedicated to a career of Naval service and have potential for future development in mind and character to assume the highest responsibilities of command, citizenship and government" (http://www.usna.edu/VirtualTour/150years, 2000). The challenge is accurately assessing the moral, mental, and physical potential of each candidate for admission. Then, the most highly qualified candidates may be offered appointments to the Naval Academy. These midshipmen will be the future leaders of the Navy and Marine Corps.

The Admissions department at USNA selects highly qualified applicants from a pool of high school students, college students, and enlisted sailors and Marines. Scholastic Aptitude Test (SAT) scores, high school grade point average (GPA), and class rank are used to successfully predict a candidate's potential for academic success. Predicting the physical readiness of prospective midshipmen is complicated by a lack of standardized performance data. Candidates apply for admission to the Naval Academy from a variety of backgrounds including high school, college, the regular Navy and Marine Corps, and the Naval Academy Preparatory School (NAPS). However, there is no universal physical fitness test similar to the SAT that is administered to all prospective candidates.

The Naval Academy requires candidates to take the Physical Aptitude Examination (PAE) in lieu of a standardized fitness test. The PAE purportedly measures

the "coordination, physical strength, speed, agility, and endurance" (Measuring and Scoring Physical Aptitude for the United States Naval Academy, 1997) of candidates for admission to the Naval Academy. The PAE is a set of four tests: a timed 300-yard shuttle run, a kneeling basketball throw, a standing longjump, and a timed flexed arm hang for women or pullups for men. The PAE is completed by the applicant and submitted with the application for admission to the Naval Academy.

The importance of admitting physically fit candidates began early in the Naval Academy's history. In a letter written by the Secretary of the Navy in 1867, "Regulations governing the admission of Candidates into the Naval Academy" outlined strict criteria for selecting prospective midshipmen. In addition to passing an academic examination with the Academic Board, a candidate was reviewed before a medical board consisting of the surgeon of the Naval Academy and two other medical officers appointed by the Secretary of the Navy. (Welles, 1867) Criteria used by the medical board were described in the admissions regulations and required a candidate to be "physically sound, well formed, and of robust constitution, and qualified to endure the arduous labors of an officer of the navy."(Welles, 1867, p.1)

In addition to general guidance in the regulations, specific conditions were also detailed for the medical board to aid in selecting candidates. No candidate was to be admitted if he was "manifestly undersized for his age."(Welles, 1867, p.1) If there were any doubt as to the candidate's "physical condition," a height and weight chart would be used to determine if he was qualified for admittance. The final guidance to the medical board beyond the subjective height requirement was a statement that the (medical) board will, "(reject) no candidate who is likely to be efficient in the service, and (admit) no one

who is likely to prove physically inefficient."(Welles, 1867, p.1) There was no test of physical ability beyond observation of the candidate in a medical examination.

By 1936, the Physical admissions requirements were more regulated. All candidates received a physical examination at the Naval Academy during the second week in June. Physical requirements for a candidate during the medical examination included that he be "physically sound, well formed and of robust constitution."(Regulations Governing the Admission of Candidates into the United States Naval Academy and Sample Examination Papers, 1936, p.13) A Table of Standards detailed the minimum weight for ages sixteen to twenty, as well as height, chest circumference at full inspiration and expiration. Medical officers were also reminded that "A high standard of physical excellence is essential in the cases of all candidates representing themselves for admission to the Naval Academy, and medical officers should always keep in view the fact that the future physical efficiency of officers of the Navy will depend largely upon the manner in which this important and exacting duty is performed." (Regulations Governing the Admission of Candidates into the United States Naval Academy and Sample Examination Papers, 1936, p. 18)

In 1951, the formal entrance physical examinations took place between May 1 and May 10. The Bureau of Naval Personnel notified each candidate when and where to report for the physical examination. Candidates were also advised to bring clothes appropriate to perform the "required physical exercises." (Regulations Governing the Admission of Candidates into the United States Naval Academy and Sample Examination Paper, 1951, p. 30) When candidates failed the formal physical examination, they were allowed to take a physical reexamination at the Naval Academy,

but these candidates were advised not to travel to Annapolis "unless they (were) convinced by a careful consideration of their personal and family circumstances that they (would) be satisfied to remain at the Naval Academy" and become midshipmen. (Regulations Governing the Admission of Candidates into the United States Naval Academy and Sample Examination Paper, 1951, p.30)

The "Physical Aptitude Examination" (PAE) first appeared in the 1952 Naval Academy Catalog. The purpose of the PAE was to "assist in the determination of muscular coordination, strength, and endurance." (Regulations Governing the Admission of Candidates into the United States Naval Academy and Sample Examination Paper, 1952, p. 40) The test consisted of pushups, pullups, Burpee (squat and thrust), situps and one arm hang. If a candidate failed to achieve a passing grade on this test, he could be rejected.

By 1963, the regulations for admittance to the Naval Academy listed five specific tests and performance criteria as part of the PAE. To successfully pass the first test, two pull-ups were to be performed using an overhand grip on a horizontal bar. The chin had to be raised completely above the bar from a full hanging position. The second test to be performed was fifteen situps in thirty seconds. The candidate, from a full lying position with knees bent and hands behind the head, had to alternately touch an elbow to each knee. The third test was ten pushups. The standard pushup had the candidate's feet raised 16 inches off the ground. With the body straight, the candidate was to lower his body until his chin touched the floor.

The last two tests were the arm hang and the duck walk. For the arm hang, the candidate had to hang from a bar "full length and completely relaxed" (Regulations

Governing the Admission of Candidates into the United States Naval Academy as Midshipmen, 1963, p. 38) with one arm then the other arm for three seconds each. The duck walk consisted of placing the hands on the hips, squatting with legs spread apart and walking ten paces. The regulations describing the PAE in 1963 specifically stated that "All candidates to the U.S. Naval Academy will be required to pass both of the following tests," the arm hang and the duck walk. (Regulations Governing the Admission of Candidates into the United States Naval Academy as Midshipmen, 1963, p. 38) Presumably if a candidate were not able to successfully complete one or more of the requirements on the pullups, situps, and pushups, he would not be rejected for that failure alone. However, if the candidate failed either of the arm hang or duck walk, he would be rejected.

The next change to the physical aptitude examination appeared in the Naval Academy Catalog of 1970-1971. The Physical Aptitude Examination in 1971 included situps, pullups, pushups, arm hang, squat walk (formerly called the "duck walk"), and "related exercises" (Annapolis: The United States Naval Academy Catalog 1970-1971, 1970, p. 161). Also, since the PAE for the other military services were basically the same as the Navy's, the Navy accepted examination results from other services. The PAE, in addition to the Qualifying Medical Examination, was also administered at Naval Examining Centers. In 1972, the Naval Academy decided that a high school coach or physical education instructor could administer the PAE instead of the Naval Examining Center.

The current version of the PAE was first administered in 1975 when the first class of women was admitted to the Naval Academy. The examination consists of pullups, a

standing broad jump, basketball throw from a kneeling position for distance, and a 300-yard shuttle run. (Annapolis: The United States Naval Academy Catalog 1975-1976, 1975) Female candidates perform the flexed-arm hang instead of pull-ups. The grading scale for the current examination was determined based on information from the five service academies (US Naval Academy (USNA), US Air Force Academy (USAFA), US Military Academy (USMA), US Coast Guard Academy (USCGA), and US Merchant Marine Academy (USMMA)). The President's Council on Physical Fitness was used to determine comparable grade scales for men and women in the broad jump, shuttle run, and basketball throw. In order to determine a grade scale for the flexed-arm hang, a low minimum requirement was set. This minimum was raised as actual performance was analyzed. Each service academy shared female PAE performance data to determine a female grade scale that was equitable to the male grade scale. (Women Midshipmen Study Group, 1987)

In a letter to the Dean of Admissions at USNA during the time when the new PAE was being implemented, the athletic director wrote that, "The PAE is valuable since it eliminates those candidates who are not capable of meeting the minimum requirements in physical education. Of the 5,307 male candidates tested for the Class of 1982, 3.1 percent were unsuitable for admission. It was also determined that 6.3 percent of the 493 female candidates for the Class of 1982 were unsuitable for admission." (Coppedge, personal communication, 1979, p.1)

Currently, a coach or physical education teacher administers the PAE to a candidate in the candidate's hometown. This differs from USAFA and USMA procedures where candidates perform the PAE at a designated site and at a designated

time. In this way, U.S. Air Force (USAF) and U.S. Army (USA) personnel may observe the manner in which the test is conducted and control for variation in administrative procedure.

The four portions of the USNA PAE are graded on a scale of 0 to 100. The minimum passing score is 100 while the maximum possible score is 400. The grade scale has changed slightly since 1976 when women were first admitted to USNA, but the events have not been modified.

The PAE at USAFA and USMA are slightly different than the PAE at USNA. The USAFA PAE includes situps, pullups, pushups and a 300-yard shuttle run, while the USMA PAE includes five events: the same four events from the USNA PAE, plus pushups. The USNA PAE application states that, "In lieu of taking our physical aptitude test, candidates who have taken the physical aptitude test as an applicant for the U.S. Military Academy may elect to request the academy to forward the results of their tests to the Naval Academy." (Measuring and Scoring Physical Aptitude for the United States Naval Academy, 1997, p.1) Candidates are also warned that doing this may result in the application being delayed due to a lack of information.

The self-proclaimed goal of the PAE is to "predict a candidate's aptitude for the physical education program at the Naval Academy." (Measuring and Scoring Physical Aptitude for the United States Naval Academy, 1997, p. 1) A large part of a midshipman's physical education grade at the Naval Academy is based on the Physical Readiness Test (PRT) score. The PRT score is 33.3% of the Physical Education grade. The Physical Education grade is 6.66% of a midshipman's overall Order of Merit. (United States Naval Academy Instruction 1531.51A, 1994) The overall Order of Merit

determines class rank. While the physical education program at the Naval Academy has many different facets, including swimming, boxing, gymnastics, and wrestling, there is one part that is constant for all midshipmen every semester: the PRT.

Once admitted to USNA, all midshipmen take the PRT every six months. The PRT consists of a 1.5-mile timed run, the maximum number of curlups (similar to conventional situps) performed in two minutes and the maximum number of pushups performed in two minutes. A score of 0 to 100 is given for each of the three events. A minimum score is necessary on each event to pass the overall PRT. Failure to meet the minimum requirement on any of the three events results in a failure. The three scores are averaged together for a combined score of 0 to 100. (Commandant Midshipmen Instruction 5400.5A, 1994)

Active duty Naval officers and enlisted personnel also take the PRT every six months. The minimum passing score for active duty officers and enlisted personnel is based on age. The minimum passing score for midshipmen is significantly higher than the minimum score for any age group for the active duty Navy PRT. If an officer or enlisted sailor fails the PRT three times in a four-year period, he or she will receive a "mandatory military bearing grade" which reflects poor PRT performance. (NAVADMIN 063/00, **http://www.bupers.navy.mil/search/search2.htmL**, 2000) If a midshipman fails to pass two consecutive PRTs, and does not pass any of the remedial PRTs, he is referred to the Physical Education Evaluation Board (PEEB) and the Physical Education Review Board (PERB) for a possible referral to the Academic Board. (COMDINST 6110.2a)

In order to decrease the number of midshipmen who are referred to an academic board because they are unable to pass the PRT, a suitable test should be administered during the admission process that will aid in predicting a midshipman's performance on the PRT. In this way, those midshipmen who may have problems passing the PRT will be identified before they are referred to the Physical Education Evaluation Board. The Naval Academy can work to strengthen those midshipmen who show signs of inability to perform the three PRT events.

In the Literature Review Chapter, I will present evidence from research conducted that demonstrates the best tests to measure an individual's fitness, as well as a review of various completed military fitness studies.

Chapter II comprises of five sections. The first section discusses the origins of physical fitness tests in the military and why they are important. The second section discusses the concept of aerobic fitness, while the third section explains the importance of muscular strength and endurance. The fourth section specifically addresses studies conducted on military personnel. The fifth section concentrates on physical aptitude and fitness in programs for military officer candidates.

There has been extensive research conducted on physical fitness and the ability of the armed forces to maintain a high state of readiness through physical training. The Navy and Marine Corps must select the most highly qualified officer candidates with potential for outstanding physical readiness. This study will determine if the PAE is the best way to predict performance on the PRT and whether or not there is a better way to screen the potential physical readiness of a candidate to the United States Naval Academy.

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II. LITERATURE REVIEW

A. INTRODUCTION

According to the National Defense University Health and Fitness Program, "Fitness is readiness" (Deuster, et al., 1987, p. 292). The military is continuously attempting to improve its readiness. In order to improve readiness, according to the NDU Health and Fitness Program, fitness must improve. The best way to discover how to improve fitness is first to measure where the military stands today with physical fitness and how to best screen prospective military personnel. Numerous studies have been conducted to measure the fitness levels of individuals in both civilian and military organizations. To date, no study has examined the relationship between the Physical Aptitude Exam and the Physical Readiness Test. This Chapter will review some of the studies conducted pertaining to physical fitness tests and fitness measurement.

An early originator of the military fitness test, Surgeon Major Francis Arthur Davy, a British Army medical officer in 1888, believed that it was impossible to judge a new recruit's fitness simply by studying his physical appearance. (Bennett, 1989) Judging a man's fitness and ability to perform specific military-related physical tasks by looks alone was widely accepted in the British Army in the 19^{th} century. Until this time, the British Army had used height, weight, and chest size to judge the quality of the recruits, very much like the US Naval Academy's standards until the PAE was implemented. Davy instead proposed to the Royal Army a test consisting of marching for 10 to 15 miles with a heavy pack, followed by running up a hill to fire at a stationary target for accuracy, to measure a recruit's physical fitness. Davy's believed that this test would provide a better estimate of a recruit's ability to perform physical actions

necessary for infantry warfare. Davy's goal was an accurate assessment of the recruit's fitness level and readiness for combat. (Bennett, 1989)

Today, battlefield commanders must know that their soldiers and sailors are both mentally and physically capable of performing the assigned tasks. In order to measure the fitness level of military personnel, fitness tests have been determined as the best way to quantify individual physical readiness.

Each branch of the U.S. military uses a different fitness test to measure its soldiers' and sailors' physical fitness. These tests vary from service to service. The Navy uses the same test as the Naval Academy, the Physical Readiness Test (PRT), to measure the fitness of its personnel. This test consists of three events: the maximum number of pushups performed in two minutes, the maximum number of curlups performed in two minutes, and a timed 1.5-mile run. The only difference between the Navy PRT and the Naval Academy PRT is the grading scale which each uses.

The Naval Academy PRT requires better minimum performance on each portion of the test in order to pass than the Navy PRT requires to pass. Minimum passing requirements for a Naval Academy male midshipman are 65 curlups, 40 pushups, and 10:30 on the 1.5-mile run. The lowest passing level, "satisfactory marginal" performance, for a 17-19 year old male in the new Navy PRT standards beginning in May 2000 are 50 curlups, 42 pushups, and 12:30 on the 1.5-mile run. "Satisfactory marginal" performance for a 20-29 year old male in the new Navy PRT standards beginning in May 2000 are 50 curlups, 19 pushups, and 15:00 on the 1.5-mile run. In order to pass the Naval Academy PRT, an 18-year old male Navy sailor would perform the following equivalent on the new Navy PRT scale: "Good Low" on curlups (62), he would not have

to pass the minimum requirement for pushups (42), and "Good Medium" on the 1.5-mile run (10:30).

For females, there is also a difference between the Naval Academy PRT grade scale and new May 2000 Navy PRT grade scale. Minimum passing requirements for a Naval Academy female midshipman are 65 curlups, 18 pushups, and 12:40 on the 1.5-mile run. The lowest passing score, "satisfactory marginal" performance for a 17-19 year old female in the new Navy PRT standards beginning in May 2000 are 50 curlups, 19 pushups, and 15:00 on the 1.5-mile run. "Satisfactory marginal" performance for a 20-29 year old female in the new Navy PRT standards beginning in May 2000 are 46 curlups, 16 pushups, and 15:30 on the 1.5-mile run. In order to pass the Naval Academy PRT, an 18-year old female Navy sailor would have to perform the following equivalent on the new Navy PRT scale: "Good Low" on curlups (62), she would not have to pass the minimum requirement for pushups (19), and "Good High" on the 1.5-mile run (12:45). (Bureau of Naval Personnel Home Page, http://www.persnet.navy.mil/navadmin/nav00/nav00063a.txt, 2000)

The inequality between the Naval Academy PRT and the Navy PRT is evident when comparing the scaled scores for each gender. In male and female curlup tests for the Navy PRT and the Naval Academy PRT, the grading scales are the same. The inequality in male and female-scaled scores occurs when comparing the pushups and the 1.5-mile run times.

In order for a male midshipman to achieve 80 out of 100 points in pushups, he must perform 71 pushups. This equates to a "good medium" in the new Navy PRT standards. In order for a female midshipman to achieve 80 out of 100 points in pushups,

she must perform 49 pushups. This equates to an "outstanding low" in the new Navy PRT standards.

In order for a male midshipman to achieve 80 out of 100 points in the 1.5-mile run, he must run the course in 9:20. This equates to an "excellent medium" in the new Navy standards. In order for a female midshipman to achieve an 80 out of 100 points in the 1.5-mile run, she must run the course in 11:10. This equates to an "outstanding medium" in the new Navy standards.

To achieve the same score on the Naval Academy PRT, female midshipmen are performing at a higher level than male midshipmen in comparison to the new Navy PRT standards that take effect in May 2000.

While the Navy uses the PRT, the Army uses the Army Physical Fitness Test (APFT) to measure individual physical fitness. The APFT consists of a timed two-mile run, pushups, and situps. (The Navy "curlups" and Army "situps" are the same exercise.) Unlike the USNA PRT, the USMA fitness test evaluates cadets on the same grade scale used by Army officers and enlisted personnel.

In the Army and Navy fitness tests, aerobic fitness, anaerobic fitness, as well as muscular endurance, are measured. Section B will define and discuss aerobic fitness.

B. AEROBIC FITNESS

Aerobic fitness is an important aspect of physical fitness. An aerobically fit person is able to continue exercising vigorously beyond 2 or 3 minutes in length. Oxygen consumption in an individual during long-term exercise rises during the first four minutes until it plateaus. This plateau of oxygen consumption is termed the Steady Rate Oxygen Uptake (Steady Rate VO_2). In theory, a person could exercise at Steady Rate VO_2

indefinitely with adequate fluids, electrolytes, and adequate fuel reserves for blood glucose and glycogen stores. (McArdle, Katch, & Katch, 1981)

In order to measure an individual's capacity for aerobic performance, various tests are conducted to increase the Steady Rate $\dot{V}O_2$. When Steady Rate VO_2 stops increasing while workload continues to increase, an individual reaches Maximal Oxygen Uptake (VO_2Max). This occurs when that individual reaches his or her limit to aerobically convert energy in the body. At this point, the body uses energy transfer of glycolysis. The result of the glycolysis is lactic acid build up. A person will not be able to continue exercising for a long period of time after reaching VO_2Max.

VO_2Max is important to aerobic fitness because it is generally regarded as "a quantitative statement of an individual's capacity for aerobic energy transfer" (McArdle, Katch, and Katch, 1981, p. 85). The length of time an individual is able to maintain this "aerobic energy transfer" defines how long a person will be able to perform a given aerobic exercise. It is interesting to note that an individual can expect to improve VO_2Max between 5 and 25 percent with regular aerobic training. (McArdle, Katch, and Katch, 1981).

There are a number of ways to measure a person's VO_2Max. In laboratory testing, the measurement of aerobic capacity, VO_2Max, is determined most accurately with an individual running on a treadmill. (Sharp, 1991, Smith, et al., 1988, Knapik, 1989, Slack, et al., 1985, Burger, et al., 1990) The treadmill test for VO_2Max is a more accurate test of aerobic capacity but ineffective to perform on all members of a military organization due to time, personnel, and equipment requirements. (Sharp, 1991) The

challenge for researchers is to determine a test that accurately predicts VO_2Max without utilizing the more time consuming and costly treadmill tests.

Some of the earliest fitness tests were developed specifically to measure aerobic fitness for military personnel. The Harvard Step Test, developed during World War II, was a precursor to some of the later, more modern tests measuring aerobic fitness. The Harvard Step Test measures an individual's pulse rate after stepping on and off a 20-inch step 30 times per minute for five minutes. Pulse rate is taken one, two, three, four and five minutes after the five-minute stepping portion is complete. VO_2Max is determined based on pulse rate and historical data. (University of Western Australia Home page, http://www.general.uwa.edu.au/u/rjwood/me.htm, 1999)

Cooper, a leading researcher in the predictive value of VO_2Max on aerobic fitness, developed the 12-minute performance run to predict VO_2max. He found a 0.897 correlation between the distance an individual has the ability to run in 12 minutes and his VO_2Max. (Williford, et al., 1994)

During an Air Force review of its fitness testing, Balke and Cooper reviewed twenty years of data and determined that the 1.5 mile run is an easily administered and a reliable test of aerobic fitness. In addition, Cooper's studies show that there is a linear relationship between VO_2Max and running speed when a subject has run for at least 10 minutes. Based on the data, Cooper believes that only exercise which requires VO_2Max will accurately give a "true measurement of fitness."(Sharp, 1991, p. 181)

During studies examined by Knapik relating running distance to VO_2Max, thirteen running trials of 60 yards to 880 yards were reviewed. The correlation between VO_2Max and running time was –0.05 to –0.78. Of 12 studies investigating the

correlation between VO_2Max and running distance of one mile or longer, those studies where the subjects ran for at least one mile or a running time of at least six minutes showed correlations of –0.29 to –0.94. When studies were examined for only two-mile runs, the correlation between VO_2Max and running time increased to a range of –0.74 to –0.94. (Knapik, 1989) This demonstrates that an individual's aerobic capacity is highly correlated to the speed at which he or she runs two miles. Furthermore, a more accurate prediction of VO_2Max is possible when the running distance is longer than one mile.

A study done of 36 South African military recruits concurred with Cooper's finding that VO_2Max is directly related to run time. The South African study used the 2.4-kilometer (1.5 miles) run time of its recruits to predict VO_2Max. Burger et al. measured the VO_2Max of eighteen subjects using a continuous graded treadmill test before basic training. Each subject, motivated to complete the course in the shortest time possible, ran the 1.5 miles on an out and back course. The correlation between run times and VO_2Max ranged between –0.76 to –0.93 for the four sets of results. Two facts were established from the study. First, run time and VO_2Max are highly correlated. Second, it was established that VO_2Max could accurately be predicted from the run time of one group of recruits using the regression equation of another group. (1990)

In summary, it is generally regarded that VO_2Max is the best quantifiable measure of an individual's aerobic fitness. Based on research conducted, any measured distance of longer than one mile gives an accurate measure of VO_2Max.

C. MUSCULAR STRENGTH/ENDURANCE

In addition to aerobic capacity, muscular strength and muscular endurance are important elements of an individual's physical fitness. Muscular strength is "the ability

of a muscle group to exert a maximal force in a single voluntary effort," while muscular endurance is defined as "the ability of a muscle group to repeat high intensity, submaximal contractions with a fixed load or percentage of body weight." (Knapik, 1989, p. 327) Muscular strength and endurance provide the battlefield commander a measure of an individual's ability to repetitively perform physical movements with a fixed load involved, such as filling a large gun's magazine with gunpowder and shells.

In Knapik's review of research examining the relationship between muscular strength and muscular endurance, it was determined that there is a high correlation between muscular strength and absolute (fixed load) muscular endurance, ranging from 0.76 to 0.95. (1989) The correlations between muscle strength and muscular endurance based on body weight are much lower, ranging from -0.03 to –0.6. Knapik investigated eight separate studies on muscle strength and endurance and determined using factor analysis that pushups, situps, and pullups are all measures of muscular strength and endurance. Both pushups and pullups, in a range of 0.42-0.81, more highly correlate to strength/endurance than do situps. However, situps also correlate to muscular strength/endurance with correlations ranging from 0.10-0.66. (Knapik, 1989) Carver and Winsmann concur with Knapik's evidence in studying the Fleishman basic Fitness Test where pullups were determined to accurately predict muscular strength. (1968)

Other tests have been conducted to investigate the relationship between job performance and muscular strength/endurance. Marcinik et al. found that physical screening tests such as situps, pushups, pullups, and a 500-yard swim test do not accurately predict the ability of a Navy diver to perform required job tasks. However, Snoddy and Henderson determined that a fitness test that includes pushups, situps and

running, could predict whether or not a recruit would successfully complete basic training. (1994)

D. FITNESS OF MILITARY PERSONNEL

Many analyses have been conducted to measure the physical fitness of active duty officer and enlisted personnel in the US military. Only in this way is the military able to assess factors such as aerobic capacity, muscular strength, and muscular endurance. The objective of many of these tests is to measure the physical readiness of military personnel. By accomplishing this, military leaders are able to assess the overall readiness of their units.

In one such test conducted by Trent and Hurtado, data was collected from 364 Navy men and women over the course of an 11-year period. They determined that on average, 1.5-mile run time, situps, and pushups, improved for the test group by the end of the 11-year test period. (1998) Diet also improved, smoking rates decreased, and alcohol consumption declined. It is interesting to note that in the physical fitness portion of the study, the female-scaled score for pushups performed in two minutes was better than the male-scaled score for pushups completed in two minutes. According to Trent and Hurtado, this may be due to the scaled scoring system requiring women to do fewer pushups than their male counterparts for the same grade. The only factors that correlated to a decrease in performance were an increase in percentage body fat, an increase in percentage overweight, and an increase in Body Mass Index (BMI).

Slack et al. recognized the importance of a lower percent body fat and attempted to determine whether percent body fat in Air Force officers was a significant predictor of physical fitness. They determined using skin fold measurements and a multistage

treadmill test that percent body fat is not a primary factor in determining physical fitness because of the wide variance in aerobic capacity and its dependence on heredity, exercise habits, and smoking. (1985)

Another study conducted using Air Force personnel attempted to validate the use of the 1.5-mile run as a cost effective replacement to measure VO_2Max of a service member. While the study determined that the 1.5-mile run is a good predictor of VO_2Max, it was found that 59.5% of the members of the Air Force do not regularly exercise. Only half of the subjects in the study meet current Air Force fitness standards, and only one third of those tested could meet the more stringent standards time standards for the 1.5-mile run. (Sharp, 1991)

In a similar study to determine the effectiveness of the Canadian military physical fitness test in predicting job performance, Stevenson et al. (1992) conducted research on 66 male and 144 female active duty military members. The investigation included comparing the Canadian physical fitness test (consisting of VO_2Max, maximum grip strength, maximum number of situps, and maximum number of pushups) to five common job tasks enlisted members were likely to perform including land evacuation, sea evacuation, entrenchment dig, sandbag carry, and low/high crawl. It was determined that the Canadian physical fitness test, in place, was able to predict not less than 14% but not more than 48% of the performance on the common tasks. From this data, Stevenson et al. determined that the physical fitness test score of an individual was related to task performance but could not be used as a predictor of task performance. In addition, they determined that the test variables relating to task performance were different for the male and female subjects.

E. SERVICE ACADEMIES AND OFFICER CANDIDATE SCHOOL

While most studies focus on all military personnel, other research has been conducted solely on the fitness of cadets and midshipmen at the service academies in order to best select the future leaders of the military. Daniels et al. conducted a study analyzing the performance of 11 male and 7 female USMA cadets five times over a two-year period beginning in 1977. The male cadets' measured VO_2Max did not change significantly over the two-year period while the females VO_2Max increased during the initial plebe summer six week training period before returning to the original level by the end of the two-year period. (1982) It was also determined that the males were able to maintain their high VO_2Max and increase muscle strength, while females showed no significant increase in any muscle strength measures when lean body mass and VO_2max increased. The differences noted between male and female cadets' aerobic power and muscle strength remained constant throughout the length of the study. As well, Daniels et al. noted that the males and females in the study group were stronger, with greater aerobic capacity, and less body fat than enlisted military personnel of the same age.

One of the first studies to determine the physiological differences between men and women entering the service academies took place in 1977. Protzmann conducted an extensive study comparing the first female class to enter USMA with their male counterparts. (1979) He found that the mean and distribution scores on the PAE for women were lower than the scores for the men, but based on their respective populations the scores were similarly distributed. From the data, Protzmann determined that men had a distinct advantage in an environment of equal physical training when the PAE acceptance criteria for women are lower than the acceptance criteria for men.

Baldi's (1991) review of service academy fitness programs for females concurs with Daniels' findings that female cadets perform much better than the general female population on physical fitness tests. Baldi reviewed data from 14 Air Training Officers (ATOs) who went to the Air Force Academy in 1979. These ATOs took part in the equivalent of 4 years of military and physical training condensed into one semester. The 14 female officers performed the PAE at the 50th percentile for civilian females nationally while the first class of females at the Air Force Academy performed at the 75th percentile nationally.

In another study, midshipmen performance in Aviation Officer Candidate School's (AOCS) 14-week program was analyzed. The overall fitness of 26 male and 4 female officer candidates was evaluated on various physical exercises before and after AOCS training. For the group of 30 individuals, there was a noticeable improvement in upper body strength, lower body strength, and aerobic conditioning. The average situp repetition increase was 14. The average 1.5-mile run decrease was 58 seconds while average body fat decreased 1%. (Woodhead and Moynihan, 1994) Although there was an improvement in every test, the pushups score did not improve significantly with an increase of only 4 repetitions per subject. Woodhead and Moynihan relate this to the possibility that the subject will achieve the maximum number of points in the pushup test at 67 pushups. In AOCS, the extra pushups completed beyond 67 are counted but do not affect the individual's overall grade. For this reason, many individuals may not have been motivated to do more than the 67 pushups for which they would receive credit. The subjects may also have been conserving energy for the 1.5-mile run immediately following the pushups and situps. Evidence of this fact is demonstrated by the fact that

50% of the subjects achieved the maximum number of pushups while 33% achieved the maximum number of situps.

To date, there have been no studies conducted investigating the Physical Aptitude Exam and its relationship to performance on the Physical Readiness Test. Therefore, based on prior research and this fitness study review, an empirical investigation of the PAE and its relationship to the PRT is necessary.

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III. RESEARCH HYPOTHESES

A. STATEMENT OF THE PROBLEM AND RESEARCH

Physical fitness plays an important role in the lives of midshipmen at the Naval Academy. The average midshipman or cadet, upon entering a service academy, is above average in physical fitness when compared to his or her civilian peers. (Baldi, 1991, Harger & Ellis, 1975) In addition, midshipmen are assigned a letter grade for physical performance on the Physical Readiness Test (PRT) each semester. This study examines variables that may predict the PRT including morphological data (ex. height, weight, Body fat percentage, Body Mass Index (BMI)) four individual PAE test scores, an overall PAE test score, and recruited/Blue Chip athlete data.

This study will attempt to determine if the variables listed may be used to better predict those midshipmen who will be able to meet the minimum standards of physical fitness at the Naval Academy. If the variables do predict performance on the PRT, then the predictors may be used by the Naval Academy to identify and help those midshipmen who are more likely to have difficulty meeting minimum fitness standards as midshipmen. The Naval Academy would be better able to concentrate on those midshipmen who are at a higher risk of PRT failure. A change in the current PAE could then be used in concert with other admissions criteria to determine the most highly qualified applicants.

Table 3.1 summarizes the hypotheses for this study as well as predicts how the independent variables will affect the dependent variables. One can read the table by matching the arrow of the independent variable's performance with the sign of the dependent variable. For example, the prediction from the chart shows that as

Armstrength Raw score increases (↑), Overall PRT score is expected to increase (+). However, in another example, when Shuttle Run Raw time decreases (↓), 1.5-mile run time is predicted to decrease (-). This chart is predicting raw performance data. It is important to remember that as Shuttle Run Raw (time) decreases (better performance), the Shuttle Run Scaled score (0-100) increases.

Independent Variables / Dependent Variables	PAE OVER ALL SCORE (0-400)	ARMSTR ENGTH RAW (Reps OR sec.)	SHUTTL ERUN RAW (sec.)	STAND LONGJU P RAW (in.)	BASKTBA L THROW RAW (ft.)	RECRUIT ATHLETE (0/1)	BLUE CHIP ATHL ETE (0/1)	AGE (yrs)	HEIGHT (in.)	WEIGHT (LBS.)	BODY FAT (%)	BODY MASS INDE X
PRT OVERALL SCORE	+↑	+↑	+↓	+↑	+↑	+↑	+↑	*	*	+↓	+↓	+↓
PUSHUPS (reps)	+↑	+↑	+↓	+↑	+↑	+↑	+↑	*	*	+↓	+↓	+↓
CURLUPS (reps)	+↑	+↑	+↓	+↑	+↑	+↑	+↑	*	*	+↓	+↓	+↓
1.5-MILE RUN TIME (min.)	-↑	-↑	-↓	-↑	-↑	-↑	-↑	*	*	-↓	-↓	-↓

Table 3.1: PAE/PRT Hypotheses

(*) Indicates that the value is expected to be minimal or insignificant.

(↑) Indicates hypothetical increase in independent variable.

(↓) Indicates hypothetical decrease in independent variable.

(+) Indicates that the dependent variable increases in relation to ↑ or ↓ .

(-) Indicates that the dependent variable decreases in relation to ↑ or ↓ .

B. HYPOTHESES AND QUESTIONS TO BE ANSWERED DURING ANALYSIS

1. Does the overall PAE score, determined from the test administered to applicants during the US Naval Academy admissions process, predict performance on the overall PRT score of the first PRT of the fall semester for male and female plebes?

Hypothesis 1: The overall PAE score, determined from the test administered to applicants during the US Naval Academy admissions process, does not predict performance on the first PRT of the fall semester for male and female plebes.

2. Do the PAE component tests (Armstrength, Basketball throw, Longjump, and Shuttlerun) individually predict performance on the overall PRT score of the first PRT of the fall semester for male and female plebes?

Hypothesis 2: Armstrength (Pullups for males, Flexed Arm Hang for females), Basketball Throw, Longjump and Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, individually do not predict performance on the first PRT of the fall semester for male and female plebes.

3. Do the PAE component tests (Armstrength, Basketball throw, Longjump, and Shuttle Run) individually predict performance on the curlup portion of the first PRT of the fall semester for male and female plebes?

Hypothesis 3: Armstrength (Pullups for males, Flexed Arm Hang for females), Basketball Throw, Longjump and Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, individually do not predict

performance on the curlup portion of the first PRT of the fall semester for male and female plebes.

4. Do the PAE component tests (Armstrength, Basketball throw, Longjump, and Shuttlerun) individually predict performance on the pushup portion of the first PRT of the fall semester for male and female plebes?

Hypothesis 4: Armstrength (Pullups for males, Flexed Arm Hang for females), Basketball Throw, Longjump and Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, individually do not predict performance on the pushup portion of the first PRT of the fall semester for male and female plebes.

4. Do the PAE component tests (Armstrength, Basketball throw, Longjump, and Shuttlerun) individually predict performance on the 1.5-mile run portion of the first PRT of the fall semester for male and female plebes?

Hypothesis 5: Armstrength, Basketball Throw, Longjump, and Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, individually do not predict performance on the 1.5-mile run portion of the first PRT of the fall semester for male and female plebes.

5. Do age, height, weight, body fat percentage, and BMI predict performance on the overall PRT score and individual PRT components of the first PRT of the fall semester for male and female plebes?

Hypothesis 6: Age, height, weight, body fat percentage and Body Mass Index do not predict performance on the overall PRT score or the individual components of the first PRT of the fall semester for male and female plebes.

7. Do male and female plebe Recruited and Blue Chip Athletes perform better on the overall PRT score and individual components of the first PRT of the fall semester than non-Recruited or non-Blue Chip athlete midshipmen?

Hypothesis 7: Male and female plebe Recruited and Blue Chip Athletes do not perform better than non-Recruited or non-Blue Chip athlete midshipmen on the overall PRT score and individual components of the first PRT of the fall semester.

IV. ANALYTICAL METHODOLOGY

A. PROTOCOL

This study consisted of 1037 male and 195 female midshipmen from the class of 2002, and 1031 male and 201 female midshipmen from the class of 2003. In order to separate the predictive effect of the PAE on the PRT from other influences such as schooling after high school prior to USNA and prior enlistment, those midshipmen who were older than 19 years older on July 1 of the year that their USNA class began plebe summer were excluded from the data set. The midshipmen who were older than 19 when entering the Naval Academy were either enlisted, attended NAPS, attended preparatory school or matriculated at another college for a period of time prior to Induction Day. Those midshipmen were removed from the data set. The resulting data set after removing midshipmen older than 19 years old on July 1 of plebe year included 770 males and 151 females from 2002 and 795 males and 177 females from 2003. The data for each class and each gender was analyzed separately to determine if the male and female class databases could be combined into a single male and a single female database. Data analysis revealed that there was enough overlap in the data of the two year-groups to combine males from 2002 with males from 2003 and females from 2002 with females from 2003. Average age for males and females for each class were similar as well as the average score for the Physical Aptitude Exam (PAE) and overall score for the Physical Readiness Test (PRT). Table 4.1 shows the comparison of average scores on the PAE, PRT, and average age for the class of 2002 and 2003 males and females prior to combining the classes.

Table 4.1: Midshipman Average Scores and Age By Gender and Class

	Average Overall PAE Score	Average Overall PRT Score	Average Age on July 1 of Induction Day Year
2002 Male	224.33	79.14	18.11
2003 Male	225.33	83.88	18.17
2002 Female	247.68	81.59	17.97
2003 Female	245.52	83.30	18.06

Table 4.2 shows the resulting number of midshipmen after excluding those older than 19 years on July 1 of year of Induction Day.

Table 4.2: Midshipman Total Number for Classes of 2002 and 2003

	2002 Overall	2003 Overall	2002 Under 19yrs	2003 Under 19yrs	2002&2003 Combined Under 19yrs
Males	1037	1031	770	795	1565
Females	195	201	151	177	328

B. MORPHOLOGICAL DATA

Morphological data for each class was obtained from the Physical Education Department's files of measurements on Induction Day. Age was calculated for the midshipmen on July 1 of the year that the midshipmen began plebe summer. Body fat percent was measured by circumference measures according to Navy standards. (NAVADMIN 063/00, http://www.persnet.navy.mil/navadmin/nav00/nav00063a.txt, 2000) Body Mass Index (BMI), the ration of weight to height, was obtained using the formula: [BMI= Mass (KG)/Height^2 (m)].

C. PHYSICAL APTITUDE EXAM

Physical fitness data for the PAE and the PRT were provided by the Institutional Research Department at the Naval Academy. PAE scores are those supplied on the

midshipman's application for admission. Each candidate took the PAE during his or her senior year of high school. The PAE consists of four events including, Pullups for males, Flexed arm hang for females, Kneeling Basketball Throw, Shuttle Run, and Standing Longjump. Each has a raw score that is converted to a scaled score between 0 and 100. The scaled scores from the four individual tests are added together to determine the overall PAE score between 0 and 400.

The pullup portion of the PAE test for males is conducted as follows: the candidate grasps the bar with palms facing away, arms fully extended with feet off the ground. The candidate raises his body until his chin is above the bar and then returns to the fully extended position. This is one repetition. The candidate will perform as many pullups as possible. The minimum number of repetitions for 25 points is 2 pullups. The maximum number of repetitions for 100 points is 25 pullups.

The flexed arm hang portion of the PAE test for females is conducted as follows: the candidate stands on a bench or chair and grasps the bar with palms facing away from her. An assistant grabs the candidate above the ankles and lifts her into the starting position. Arms are fully flexed and the chin is level above the bar. When the candidate is in the starting position, the assistant lets go of the candidate's legs and the stopwatch is started. The candidate stays in the starting position for as long as possible. The stopwatch is stopped when the candidate's chin rests on or drops below the bar. The minimum score for 25 points is 12 seconds. The maximum score for 100 points is 68 seconds.

Both males and females perform the standing longjump portion of the PAE. The candidate takes the starting position with both feet positioned at the takeoff line. The

candidate attempts to jump as far as possible. The jump is measured from the takeoff line to the rearmost heel on landing. The candidate takes three jumps, and the longest jump is recorded on the score sheet. The minimum jumps for males and females are 62 inches and 53 inches respectively. Each of these jumps equals 3 points. The maximum jumps for males and females are 110 inches and 87 inches respectively. Each of these jumps equals 100 points.

Both males and females perform the kneeling basketball throw portion of the PAE. The candidate attempts to throw a basketball as far as possible from a kneeling position on a mat or padded surface. Only knees and feet may be in contact with the mat, and hands cannot touch the mat during the test. The candidate makes three attempts to throw the basketball as far as possible. The minimum throws for males and females are 39 feet and 23 feet respectively. Each of these throws equals 12 points. The maximum throws for males and females are 95 feet and 66 feet respectively. Each of these throws equals 100 points.

The fourth test conducted in the PAE is the 300-yard timed shuttle run. The candidate will make six round trips between two lines 25 yards apart. The candidate only has to touch the line, not run past the line. The administrator of the test will call out the number of round trips completed each time the candidate reaches the start line. For males and females the minimum allowable passing times to complete the 300-yard shuttle run are 69.2 seconds and 91.5 seconds respectively. This equals 11 points. The best time for males and females are 50.1 seconds and 59.0 seconds for males and females respectively. These times equal 100 points. (Measuring and Scoring Physical Aptitude for the US Naval Academy, 1997)

The overall PAE score used in this study was determined by adding the scaled scores from the four PAE tests. For example, a candidate did 8 pullups (46 points), 90 inches on the longjump (50 points), threw the basketball 66 feet (50 points), and ran the shuttle run in 60.3 seconds (50 points). The overall PAE score used for the sample midshipman in this study was determined by adding 46+50+50+50 for a total of 196 points for an overall PAE score.

Raw data were used for individual PAE events. Examples include 8 pullups, 90 inches on the longjump, 66 feet on the basketball throw, and 60.3 seconds on the shuttle run. Raw PAE data were used so that the data would be continuous and linear. Scaled data were not used for individual PAE events.

D. PHYSICAL READINESS TEST

The first PRT of fall semester plebe year was used for this study. This was done to exclude the effect that increased motivation from peers and everyday life at USNA would provide to some midshipmen to increase their amount of physical fitness activity, improve their fitness level, and thus, improve their PRT score. This would further raise their level of fitness from the date on which they took the PAE. This study attempted to keep constant the physical fitness for every subject from PAE testing to PRT testing. Although plebe summer has a positive influence on the plebe class's physical fitness, it was determined that each plebe goes through the same physical training plebe summer.

All midshipmen take the Physical Readiness Test (PRT) every six months. The PRT consists of the maximum number of curlups performed in two minutes, the maximum number of pushups performed in two minutes, and a timed 1.5-mile run.

A score of 0 to 100 is given for each of the three events on the PRT. A minimum score of 60 percent is necessary on each event to pass the overall PRT. Failure to meet the minimum requirement of 60 points out of 100 on any of the three events results in a failure of the overall PRT. The three individual PRT scores are averaged together for a score of 0 to 100. This overall PRT score will be used as part of a midshipman's physical education grade each semester.

The curlup portion is the first part of the PRT administered. The midshipman begins in the start position, laying on his back, his arms crossed on his chest with his hands on his collar bone, and his knees bent to form a 90 degree angle between the upper and lower legs. When the instructor begins timing, the midshipman bends at the waist, raising his upper body with his arms on his chest so that his elbows touch his thighs. He returns to the start position with shoulder blades touching the floor. (CMDTMIDINST 6110.2A, 1994) This is one curlup repetition. The male and female midshipman curlup grading scale is the same. 65 Curlups is the minimum number necessary to achieve 60 points and pass the test. In order to achieve the maximum 100 points for the curlup portion of the PRT, a midshipman must perform 101 curlups.

The second part of the PRT is the pushup test. The midshipman begins in the starting position with hands approximately shoulder width apart, body off the ground with back and legs straight. When the instructor begins timing, the midshipman lowers himself until his chest touches his partner's shoe on the floor under him. He then raises himself back to the start position. (CMDTMIDINST 6110.2A, 1994) This is one repetition of a pushup. The midshipman has two minutes to perform as many pushups as possible. Resting is only allowed in the start position during this test. The minimum

number of pushups required to achieve 60 points and pass the test for males and females is 40 and 18 respectively. The maximum number of pushups to achieve 100 points for males and females is 101 and 85 pushups respectively.

The 1.5-mile timed run is the last portion of the PRT. Midshipmen run 1.5 miles while an instructor times the run. The run is conducted around the perimeter of Dewey Field, Halsey Field House, or Ingram field. (CMDTMIDINST 6110.2A, 1994) The minimum time necessary to achieve 60 points for males and females on the 1.5-mile run is 10:30 and 12:40 respectively. The maximum necessary to achieve 100 points on the 1.5-mile run for males and females is 8:15 and 9:35 respectively.

Individual PRT raw scores were used for this study. Number of curlups performed, number of pushups performed, and run time were used for continuous, linear data. Overall PRT score was determined in the following way: each of the three PRT events, 1.5-mile run, pushups, and curlups, is graded on a scale of 0 to 100. These three scores are added together and divided by 3 to determine an averaged score from 0 to 100 for a midshipman's overall PRT grade. For example, a midshipman performs 92 curlups (89.7 points), 92 pushups (93.8 points), and runs the 1.5-mile run in 9:20 (80.4 points). His overall PRT score equals (89.7+93.8+80.4)/3 = 87.97.

E. RECRUITED AND BLUE CHIP ATHLETE DATA

Data for recruited athletes and blue chip athletes was provided by the Institutional Research Department. A Blue Chip athlete is a recruited athlete who is granted a letter of assurance by the admissions board at the US Naval Academy. A letter of assurance is a guaranteed offer of appointment if the recruited athlete meets certain criteria. The candidate must be academically qualified, meet SAT requirements, pass the medical

examination, pass the PAE, and receive a nomination. If he or she meets these requirements, he or she is guaranteed an appointment to the US Naval Academy with the letter of assurance.

A recruited athlete is a candidate who has a sports code attached to his file in the admissions board database. This sports code identifies the sport the athlete is being recruited to play.

F. DEPENDENT AND INDEPENDENT VARIABLES

In Table 4.3, dependent variables are listed for males used during the frequencies, cross tabulations, and regression analysis with the variable label, description of the variable, and the measure of the variable. In Table 4.4, dependent variables are listed for females. The pass/fail variables, PRTPAFA (PRT Pass/Fail) and PAEPAFA (PAE Pass/Fail), were created by using 70% for the PRT as the minimum to pass and 200 on the PAE as the minimum to pass. The data showed that the bottom 10% of males was below 68.97 on the PRT while the bottom 10% of females was below 70.96 on the PRT. PUPAFA (Pushup Pass/Fail), CUPAFA (Curlup Pass/Fail), and RUNPAFA (Run Pass/Fail) were created by using the bottom 10% cut off scores on the individual PRT tests. If a person was below the 10% grade line, he or she received a 0 for that event. The top 90 % was given a 1 for completing above the 10^{th} percentile on each physical fitness test.

The variable IND PRT (INDIVIDUAL PRT TESTS PASS/FAIL) was created by adding the number of times a person scored above the 10^{th} percentile on the three PRT tests. If a midshipman scored above the 10^{th} percentile on all three tests, he or she

received a 3. If he or she scored below the 10^{th} percentile on one test, he or she received a 2. If he or she scored below the 10^{th} percentile on all three tests, he or she received a 0.

The variable, NPAE (PAE overall score quartiles), is the overall quartile breakdown of PAE scores. If a midshipman was in the top 25% of the class for the overall PAE score, he or she received a 4. If he is or she was in the bottom 25% of the class in the PAE, he or she received a 1.

Table 4.3: Dependent Variables for Males

Variable Label	Description of Variable	Measure of Variable
Pushups	Number of pushups completed on PRT	Repetitions
Curlups	Number of curlups completed on PRT	Repetitions
PRT Run Time	Time to complete 1.5-mile PRT Run	Minutes
PRT	Score on overall PRT	Scaled 0-100
PRTPAFA	PRT score of Pass/Fail 70 or above = Pass (1) Below 70 = Fail (0)	1 = Pass 0 = Fail
PUPAFA	Pushup score of Pass/Fail 50 pushups or above = Pass (1) Below 50 pushups = Fail (0)	1 = Pass 0 = Fail
CUPAFA	Curlups score of Pass/Fail 68 curlups or above = Pass (1) Below 68 curlups = Fail (0)	1 = Pass 0 = Fail
RUNPAFA	Run time of Pass/Fail Run time <= 10.15 = Pass (1) Run time > 10.15 = Fail (0)	1 = Pass 0 = Fail

Table 4.4: Dependent Variables for Females

Variable Label	Description of Variable	Measure of Variable
Pushups	Number of pushups completed on PRT	Repetitions
Curlups	Number of curlups completed on PRT	Repetitions
PRT Run Time	Time to complete 1.5-mile PRT Run	Minutes
PRT	Score on overall PRT	Scaled 0-100
PRTPAFA	PRT score of Pass/Fail 70 or above = Pass (1) Below 70 = Fail (0)	1 = Pass 0 = Fail
PUPAFA	Pushup score of Pass/Fail 27 pushups or above = Pass (1) Below 27 pushups = Fail (0)	1 = Pass 0 = Fail
CUPAFA	Curlups score of Pass/Fail 67 curlups or above = Pass (1) Below 67 curlups = Fail (0)	1 = Pass 0 = Fail
RUNPAFA	Run time of Pass/Fail Run time <= 12.01 = Pass (1) Run time > 12.01 = Fail (0)	1 = Pass 0 = Fail

In Table 4.5, all independent variables for males and females are listed.

Table 4.5: Independent Variables for Males and Females

Variable Label	Description of Variable	Measure of Variable
Alpha	Midshipman Alpha Code	
Age	Age on July 1 of plebe summer	Years
Gender	Male (0) of Female (1)	Male = 0 Female = 1
Height	Individual's height on Induction Day	Inches
Weight	Individual's weight on Induction Day	Pounds
Body fat	Individual's body fat percentage on Induction Day	Percent
BMI	Body Mass Index = Mass (KG)/Height^2 (m)	
PAE Overall Score	Longjump scaled score + Basketball scaled score+ Armstrength scaled score+ Shuttlerun scaled score	0-400
Longjump Raw	Longjump Raw score	inches
Longjump Score	Longjump Scaled score	0-100
Shuttlerun Raw	Shuttle Run Raw score	Seconds
Shuttlerun Score	Shuttle Run Scaled score	0-100
Basketball Raw	Basketball Throw Raw score	Feet
Basketball Throw Score	Basketball Throw Scaled score	0-100
Armstrength Raw	Males: number of pull-ups Females: time in seconds for flexed arm hang	Males: repetitions Females: seconds
Armstrength Score	Armstrength scaled score	0-100
PAEPAFA	PAE Pass Fail Score Pass if PAE >= 200 Fail if PAE < 200	1 = Pass 0 = Fail

Table 4.5: Independent Variables for Males and Females - CONTINUED

INDPRT	Individual PRT Tests passed or failed	0 = Failed all 3 1 = Passed 1 2 = Passed 2 3 = Passed all 3
NPAE	PAE overall score quartiles	Males Females 000-190=**1**=000-208 190-222=**2**=208-246 222-256=**3**=246-287 256-400=**4**=287-400
Blue Chip	Blue Chip Athlete	1 = Blue Chip 0 = not Blue Chip
Recruit	Recruited Athlete	1 = Recruited Athlete 0 = not Recruited Athlete

Frequency charts and cross tabulations were created to determine the characteristics of the data, such as average score on the individual tests of the PAE and PRT as well as the overall scores in order to compare genders and classes. Then, binary LOGIT analysis was conducted on the male and female subsets to determine the effect of the PAE in predicting performance on the PRT. Regression analysis was used to analyze the individual PRT events against the individual PAE events. Both sets of tests (male and female) have raw, linear, continuous data.

In order to regress the overall PAE score against the overall PRT, dichotomous dependent variables were created. The testing scale for the PAE individual tests is not linear, nor is the grading scale for the overall PRT score. For these reasons, dichotomous variables and LOGIT analysis were necessary.

V. ANALYSIS OF DATA AND HYPOTHESES

A. INTRODUCTION

This Chapter presents and analyzes the data employed in this study. In an effort to characterize the data, the first section observes frequencies and cross tabulations. Graphs and Tables are provided to assist the reader in understanding the relationship between the Physical Readiness Test (PRT) and the Physical Aptitude Examination (PAE). Comparisons are made among genders to ascertain if there are particular groups of males or females that do significantly worse on the overall PRT and its individual events. There is also an examination of whether physiological data and recruited athlete status affect performance on the PRT.

The second section of this Chapter formally evaluates the hypotheses specified in Chapter three by analyzing performance on the PRT based on the PAE, physiological data, and recruited athlete status. The primary factors examined are a midshipman's ability to achieve in the top 90% of study participants in four regressions: overall PRT score, number of pushups completed, number of curlups completed, and 1.5-mile run time.

The final two sections of this Chapter utilize the models determined in Section C to predict midshipman performance on the PRT based on PAE results. Logistic and linear regression models and PAE scores are utilized to estimate predicted PRT score and a midshipman's probability of scoring 70 points on the PRT.

B. CHARACTERIZING DATA (FREQUENCIES AND CROSS TABULATIONS)

1. Morphological Data

A characterization of the data is presented in Tables 5.1 and 5.2. The mean age for males was 18.13 years, while the female mean age was 18.05 years. As expected, mean height and mean weight were higher for males while females had a higher body fat percentage. Body Mass Index (BMI) for males and females were 23.7 and 22.7 respectively.

Table 5.1 Morphological Data Characterization of Males

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years on July 1 of Plebe Yr	783	16.89	19.00	18.1281	.4125
height(inches)	771	60.50	80.50	70.3275	2.8661
Weight(pounds)	728	105	274	166.88	25.10
Body Fat Percentage	757	1	27	12.36	4.50
Body Mass Index	726	16.59	35.79	23.7181	2.9041
Valid N (listwise)	713				

Table 5.2 Morphological Data Characterization of Females

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years on July 1 of Plebe Yr	164	16.93	18.99	18.0547	.4492
height(inches)	161	58.00	72.50	65.1335	2.6063
Weight(pounds)	151	93	194	137.01	19.29
Body Fat Percentage	157	14	38	24.61	4.72
Body Mass Index	151	17.61	32.79	22.7104	2.5438
Valid N (listwise)	147				

2. PRT Data

Raw PRT data is presented in Tables 5.3 and 5.4. The mean male overall PRT score was slightly lower than the mean female overall PRT score. In the curlup test, the only portion of the PRT in which males and females perform to the same standard, males

did slightly better than females, on average performing 1.67 more curlups. The difference between mean male and female pushup scores was approximately 23 pushups while the mean male 1.5-mile run time was 1.65 minutes faster than the mean female run time.

The curlups portion of the PRT is not normally distributed. However, both the pushup and run portions of the PRT are normally distributed. This is due to the large number of male and female midshipmen's' ability to perform 101 curlups, the maximum number of curlups required. The CUPAFA dependent variable for men and women in the regression analysis becomes a truncated dependent variable for this reason.

Table 5.3 Raw PRT Data for Males

	N	Minimum	Maximum	Mean	Std. Deviation
Pushups (number)	758	39	112	74.34	17.90
Curlups (number)	758	33	119	87.25	13.04
PRT Run Time (minutes)	758	7.60	11.73	9.3003	.6349
PRT score (overall)	757	55.00	99.90	81.7208	10.2405
Valid N (listwise)	757				

Table 5.4 Raw PRT Data for Females

	N	Minimum	Maximum	Mean	Std. Deviation
Pushups (number)	149	18	110	51.47	18.40
Curlups (number)	149	47	103	85.58	13.15
PRT Run Time (minutes)	150	8.42	13.03	10.9552	.8988
PRT score (overall)	139	55.00	99.90	82.4403	9.0437
Valid N (listwise)	139				

In Table 5.5 and Table 5.6, the breakdown of mean PRT scores for males and females is shown. Female PRT scores at each quartile are slightly higher than male PRT scores.

Table 5.5 Quartiles of PRT Scores for Males

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-75.4	182	23.2	24.0	24.0
	75.4-82.1	185	23.6	24.4	48.5
	82.1-89.0	192	24.5	25.4	73.8
	89.0-100	198	25.3	26.2	100.0
	Total	757	96.7	100.0	
Missing	System	26	3.3		
Total		783	100.0		

Table 5.6 Quartiles of PRT Scores for Females

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-76.9	29	17.7	20.9	20.9
	76.9-82.7	39	23.8	28.1	48.9
	82.7-89.6	39	23.8	28.1	77.0
	89.6-100	32	19.5	23.0	100.0
	Total	139	84.8	100.0	
Missing	System	25	15.2		
Total		164	100.0		

In Table 5.7 and Table 5.8, the number of midshipmen who scored above the bottom 10^{th} percentile in each of the three PRT tests is shown. Only 2 females failed to score above the bottom 10% in any of the three PRT tests while 15 males failed to score above the bottom 10% in any of the three PRT tests. While a total of 24.1% of males failed to score above the bottom 10% in one or more of the three PRT tests, 24.8% of the females failed to score above the bottom 10% in one or more of the three PRT tests. In both groups, approximately one quarter has difficulty scoring above the bottom 10% in all three PRT tests.

Table 5.7 Individual PRT Tests PassFail for Males

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	passed none	15	1.9	2.0	2.0
	passed 1 of 3	38	4.9	5.0	7.0
	passed 2 of 3	130	16.6	17.2	24.1
	passed all 3	575	73.4	75.9	100.0
	Total	758	96.8	100.0	
Missing	System	25	3.2		
Total		783	100.0		

Table 5.8 Individual PRT Tests PassFail for Females

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	passed none	2	1.2	1.3	1.3
	passed 1 of 3	9	5.5	6.0	7.4
	passed 2 of 3	26	15.9	17.4	24.8
	passed all 3	112	68.3	75.2	100.0
	Total	149	90.9	100.0	
Missing	System	15	9.1		
Total		164	100.0		

3. Raw and Scaled PAE Data

Raw and scaled PAE data is presented in Tables 5.9 and 5.10. The PAE Overall Score was determined by combining the Longjump Score, Shuttle Run Score, Basketball Throw Score, and Armstrength Score. The maximum possible PAE overall score is 400.

Females tended to perform better in the PAE than their male counterparts. In this study the mean female PAE overall score was 18.7 points higher than the mean male score. Females slightly outperformed males in Longjump Score and Armstrength Score while mean female Shuttle Run Score was 12.5 points higher than the mean male Shuttle Run Score. The difference in mean male and female Shuttle Run Scores accounted for most of the difference between the male and female PAE overall scores.

Table 5.9 Raw and Scaled PAE Data for Males

	N	Minimum	Maximum	Mean	Std. Deviation
Longjump Raw (inches)	774	67	125	93.94	8.65
Longjump Score	777	12.50	100.00	61.2483	18.4500
Shuttle Run Raw(seconds)	777	44.70	70.00	59.1206	3.6728
Shuttle Run Score	777	.00	100.00	57.0676	15.2354
Basketball Throw Raw(feet)	777	24.00	99.00	66.1653	11.6915
Basketball Throw Score	777	.00	100.00	52.7579	17.1409
Armstrength Raw(repetitions/seconds)	777	2.00	35.00	10.2021	5.1600
Armstrength Score	777	25.00	100.00	53.0564	16.672[illegible]
PAE Overall Score	777	102.67	375.76	224.3645	47.7585
Valid N (listwise)	774				

Table 5.10 Raw and Scaled PAE Data for Females

	N	Minimum	Maximum	Mean	Std. Deviation
Longjump Raw (inches)	163	55	90	74.82	7.14
Longjump Score	163	10.71	100.00	63.1145	19.6266
Shuttle Run Raw(seconds)	162	53.70	86.70	67.3580	5.6139
Shuttle Run Score	162	19.23	100.00	69.5314	18.1650
Basketball Throw Raw(feet)	163	22.00	67.00	38.4417	8.3637
Basketball Throw Score	163	.00	100.00	52.9120	15.6357
Armstrength Raw(seconds)	163	9.00	69.00	28.4172	13.8764
Armstrength Score	163	.00	100.00	57.3676	19.4615
PAE Overall Score	163	147.44	341.88	243.1124	48.9892
Valid N (listwise)	162				

4. PRT and PAE Data Comparison

In Tables 5.11 through 5.15, the mean male individual PAE scores and the PAE overall score for each quartile score of the PRT will be graphed. This shows a graphic representation of the average PAE scores versus the PRT quartile scores.

In Table 5.14, the male basketball throw score is the only graph of score versus PRT quartile that does not hold a linear form.

Table 5.11

Mean PAE OA vs. PRT Quartiles

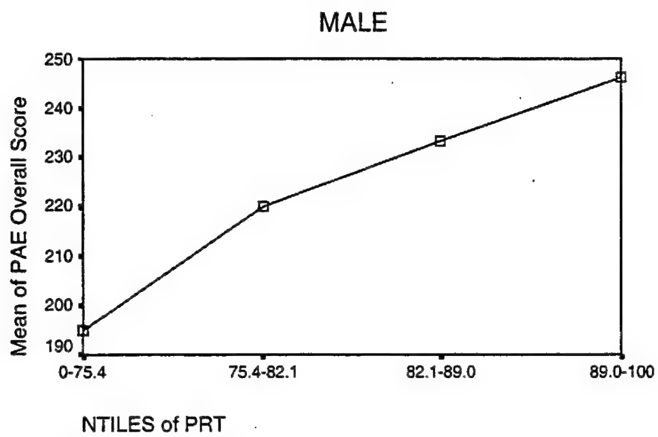


Table 5.12

Mean Longjump Raw vs. PRT Quartiles

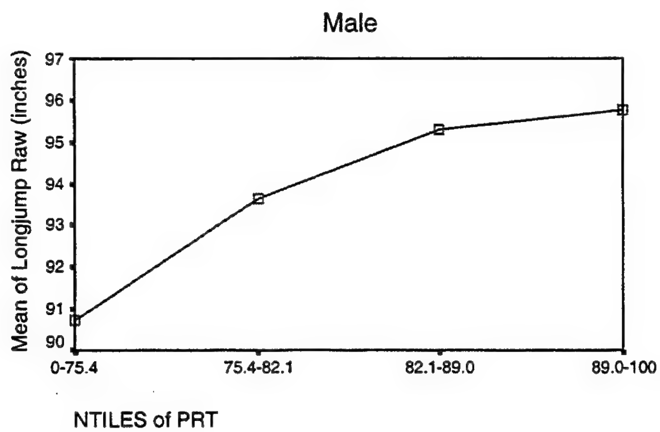


Table 5.13

Mean Shuttle Run Raw vs. PRT Quartiles

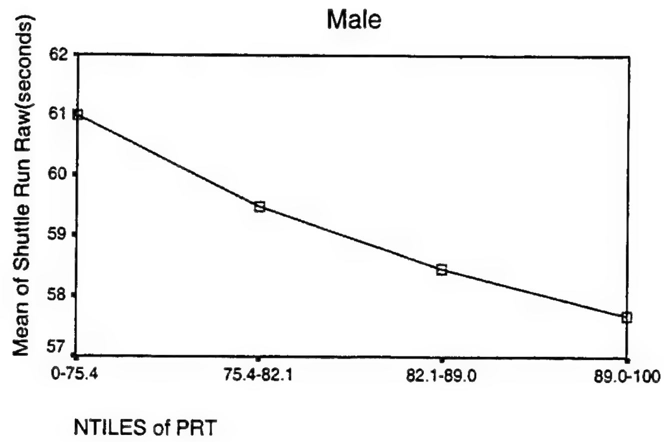


Table 5.14

Mean BasketballThrow Raw vs. PRT Quartiles

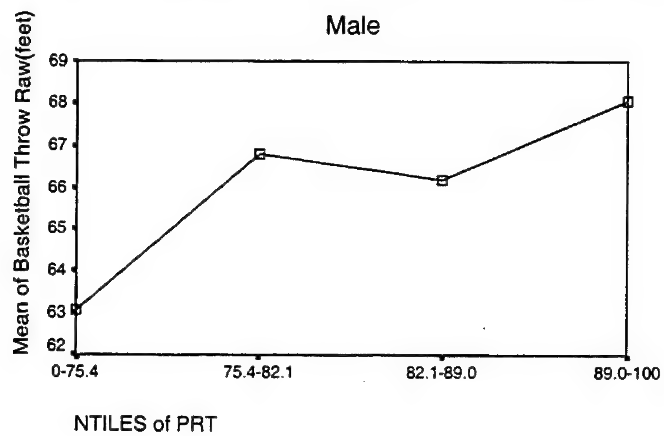
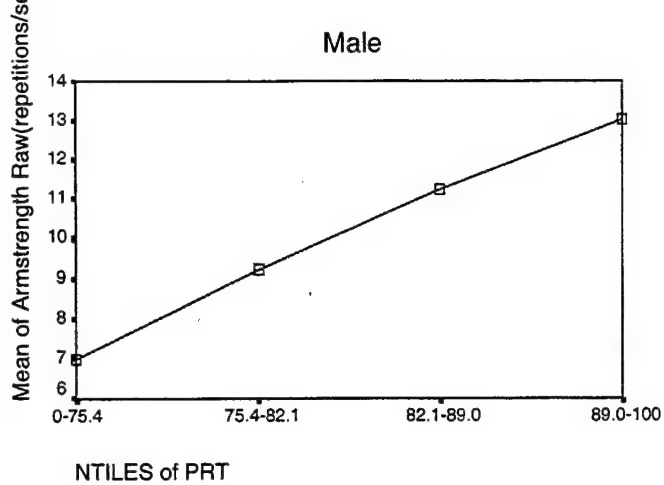


Table 5.15

Mean Armstrength Raw vs. PRT Quartiles



In Tables 5.16 through 5.20 the female PAE mean scores are graphed against the PRT Quartile scores. The Mean PAE Overall score graphed against the PRT Quartile score is linear. The individual PAE scores in Tables 5.17 through 5.20 are not linear.

Table 5.16

Mean PAE OA vs. PRT Quartiles

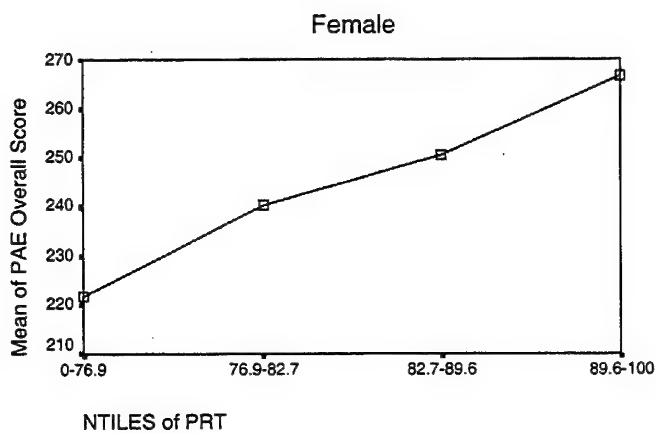


Table 5.17

Mean Longjump Raw vs. PRT Quartiles

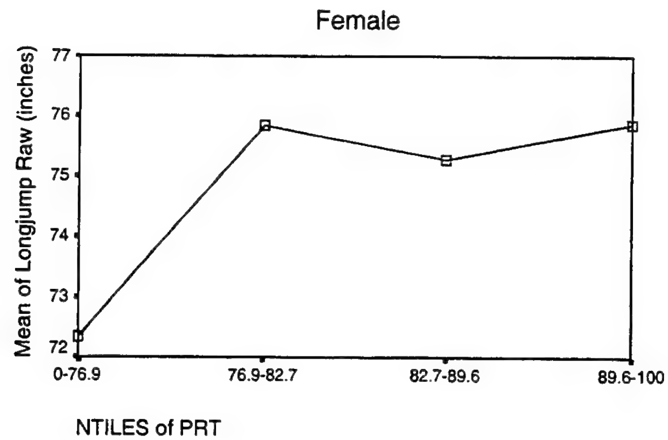


Table 5.18

Mean Shuttle Run Raw vs. PRT Quartiles

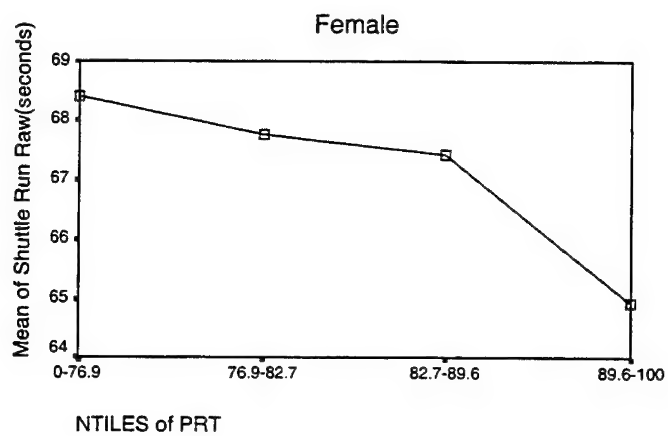


Table 5.19

Mean Basketball Throw vs. PRT Quartiles

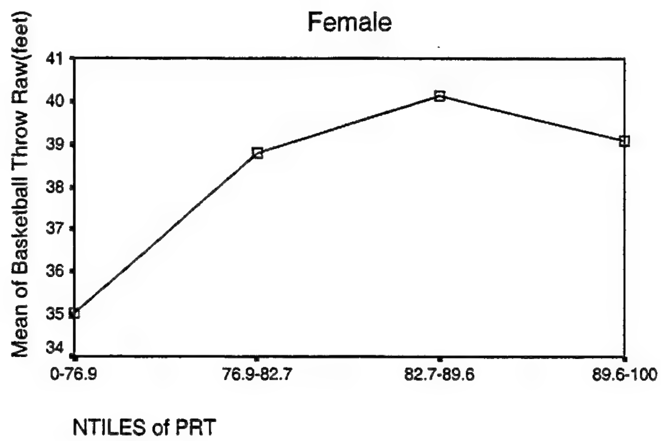
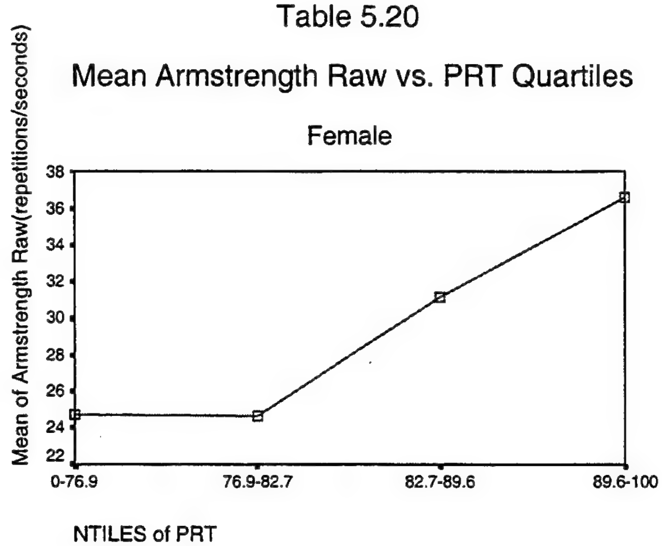


Table 5.20

Mean Armstrength Raw vs. PRT Quartiles



5. Cross Tabulations

In Table 5.21 and Table 5.22, cross tabulations are shown comparing male PRT Overall scores to PAE Overall quartile scores. It is interesting to note that in Table 5.21, of 84 males that scored lower than 70 on the overall PRT score, 50 of those males scored

lower than 190 on the PAE. The percentage of males who scored less than 70 on the PRT decreases as PAE score increases.

Table 5.21 Male PRT>=70 * PAEoverallscore quartiles Crosstabulation

Count

		PAEoverallscore quartiles				
		0-190	190-222	222-256	256-400	Total
prt >= 70 (FILTER)	Fail	50	18	11	5	84
	Selected	143	159	192	173	667
Total		193	177	203	178	751

In Table 5.22, the number of males who failed individual tests on the PRT is compared to those who scored in the four quartiles on the PAE. Note that as the PAE overall score increases the likelihood of failing one or more PRT tests decreases. Of the 193 males who scored in the bottom quartile in the PAE, 85 (44%) failed at least one individual PRT test. In the top three quartiles combined, only 17% failed at least one individual PRT test. The percentage of males who failed individual PRT tests more than doubled when they scored in the bottom quartile on the PAE.

Table 5.22 Male Individual PRT tests PassFail * PAEoverallscore quartiles Crosstabulation

Count

		PAEoverallscore quartiles				
		0-190	190-222	222-256	256-400	Total
Individual PRT tests PassFail	passed none	13		1		14
	passed 1 of 3	18	10	8	2	38
	passed 2 of 3	54	28	25	21	128
	passed all 3	108	139	170	155	572
Total		193	177	204	178	752

In Tables 5.23 and 5.24, cross tabulations are shown for females. One of six females who scored below the 50th percentile in the PAE failed to score 70 points or more in the PRT, while those above the 50^{th} percentile in the PAE failed approximately once in 34 times.

Table 5.23 Female PRT >= 70 (FILTER) * PAE Quartiles Crosstabulation

Count

		PAE Quartiles				Total
		0-208	208-246	246-287	287-400	
prt >= 70 (FILTER)	Fail	5	5	1	1	12
	Selected	30	30	35	31	126
Total		35	35	36	32	138

In Table 5.24, nineteen (46%) of the 41 females who scored in the bottom quartile in the PAE failed one or more of the three PRT tests. In the top three quartiles, 23% of the females failed one or more individual PRT test. The individual PRT failure rate is double for women in the PAE bottom quartile.

Table 5.24 Female Individual PRT tests PassFail * PAE Quartiles Crosstabulation

Count

		PAE Quartiles				Total
		0-208	208-246	246-287	287-400	
Individual PRT tests PassFail	passed none	1		1		2
	passed 1 of 3	4	4	1		9
	passed 2 of 3	14	5	5	2	26
	passed all 3	22	28	30	31	111
Total		41	37	37	33	148

C. REGRESSION ANALYSIS

Logit regression analysis was conducted to determine the effect of specified explanatory variables on the likelihood of scoring in the top 90 % of the class on individual PRT tests and the overall PRT test. Standard linear regression was to determine a model and test the model on a predicted database in Section D. PAE Raw data was used instead of scaled data because the PAE grading scale is not a linear transformation of the raw data, and the regression results are, therefore, easier to interpret. Each regression was completed for males and females for the overall PRT test

and for each individual PRT test. The following rules were used to assess the significance of variables from the initial models:

<.01 – Highly significant

.01-.05 – Significant

.05-.10 – Marginally significant

<.10 – Less than marginally significant

The variables used in this Chapter are the same variables discussed in Chapter IV and are considered as possible explanatory variables in all of the regressions estimated. All initial models were developed by using Table 3.1 in Chapter III. This Table included the expected signs of the coefficients of the explanatory variables. For each set of regressions, the same six regressions will be run for each dependent variable. Only the dependent variable (MALE or FEMALE PUPAFA, CUPAFA, and RUNPAFA) will change with each set of six regressions. MALE and FEMALE PUPAFA, CUPAFA, and RUNPAFA regressions are in Appendix A for males and Appendix B for females.

1. Male PRTPAFA Data

The regression to determine whether PAE performance predicts PRT performance began with the initial specification of the likelihood of passing the PRT as follows:

$$\mathbf{LN\ (\ P_{prtpafa}/(1\text{-}P_{prtpafa}))\ =B_0 + B_1PAEoverallscore,}$$

Where $\mathbf{LN\ (\ P_{prtpafa}/(1\text{-}\ P_{prtpafa}))}$ = log of the odds of scoring 70 or greater on the PRT.

There were 751 cases used in this analysis. The result in Table 5.25 shows that overall PAE score is highly statistically significant in predicting overall PRT score pass or fail.

In order to determine if a better model is possible examining the individual PAE tests, the overall PAE was split into its four individual tests. The model specification with results is as follows:

LN ($P_{prtpafa}/(1- P_{prtpafa}$)) = B_0 + B_1 Armstrength Raw + B_2Basketball Throw Raw + B_3Longjump Raw + B_4 Shuttlerun Raw,

There were 748 males included in this analysis. As shown in Table 5.26, Armstrength_Raw and Shuttlerun_Raw were highly significant in predicting overall PRT pass or fail, while Longjump and Basketball Throw were not significant.

In Table 5.27, results of the regression including only the significant PAE individual events show that Armstrength_Raw is positively associated with PRTPAFA while Shuttlerun time negatively correlates to PRTPAFA. As a male midshipman does more pull-ups or decreases his shuttle run time, he increases the likelihood of scoring over 70 on the PRT.

Table 5.25 Initial Model: Male Likelihood of Passing PRT(PRTPAFA) vs. PAE Overall Score

Variable	B	Wald [1]	Sig
PAE	.0230	53.4760	.0000
Constant	-2.6811	18.9081	.0000

N= 751, Chi Square = 67.195, Significance = .000

Table 5.26 Initial Model: Male Likelihood of Passing PRT(PRTPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	.0019	.0109	.9169
SHTLRU_R	-.1521	12.4673	.0004
BBTHRW_R	-.0003	.0008	.9781
ARMSTR_R	.2358	36.2684	.0000
Constant	9.1894	6.1384	.0132

N= 748 , Chi-squared = 104.761, Significance=.0000

[1] The Wald number equals t-squared in large samples.

Table 5.27 Alternate Model: Male Likelihood of Passing PRT(PRTPAFA) vs. Significant PAE Events

Variable	B	Wald	Sig
SHTLRU_R	-.1546	15.9385	.0001
ARMSTR_R	.2359	37.7299	.0000
Constant	9.5027	14.9528	.0001

N=751, Chi-squared= 104.761, Significance=.0000

In the following regression, all variables from Chapter III were added to determine the significant predictors of performance on scoring 70 or more on the PRT. The model specification with results is as follows:

$LN(P_{prtpafa}/(1-P_{prtpafa})) = B_0 + B_1$ Armstrength Raw + B_2Basketball Throw Raw + B_3Longjump Raw + B_4 Shuttlerun Raw +B_5 Age +B_6 Height + B_7 Weight + B_8 Bodyfat +B_9 BMI +B_{10} Bluechip + B_{11} Recruit.

In this regression, there were no new independent significant variables so the alternate model for the model displayed in Table 5.28 is the same as the model displayed in Table 5.27. Armstrength_Raw (.0000)[2] is highly statistically significant and Shuttlerun_Raw(.0584) is marginally statistically significant.[3] There also was no evidence of multicollinearity to cause insignificance of independent variables.

In Table 5.29, results of the specification of PRTPAFA and Male PAE quartiles shows that the PAE score is highly statistically significant(.0000) in predicting performance for the bottom quartile of male midshipmen, those who scored between 0-190 on the PAE. The PAE is still significant, but not as significant(.0083), for those

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[2] A significance level of (.0000) means that the significance level is less than (.0001)

[3] PRT overall score was also regressed against PAE overall score and all other morphological independent variables with no difference in results from Table 5.25. PAE overall score was the only significant independent variable.

the PAE is not significant (.2131) for those midshipmen in the second quartile of PAE score. The first quartile, those midshipmen who scored between 256-400 points on the PAE, was used as a reference group.

Table 5.28 Initial Model: Male Likelihood of Passing the PRT(PRTPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
AGE	-.1787	.2872	.5920
HEIGHT	.1844	.2976	.5854
WEIGHT	-.0356	.2775	.5984
BODYFAT	-.0437	.8891	.3457
BMI	.1872	.1440	.7043
LONGJP_R	-.0059	.0799	.7775
SHTLRU_R	-.0897	3.5836	.0584
BBTHRW_R	.0098	.5504	.4581
ARMSTR_R	.2267	26.5401	.0000
BLUECHIP	.2134	.0887	.7658
RECRUIT	.4734	.6281	.4281
Constant	-2.2056	.0077	.9303

N= 684, Chi-squared= 101.260, Significance=.0000

Table 5.29 Model: Male Likelihood of Passing the PRT(PRTPAFA) vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		49.5020	.0000
NPAE(1)	-2.4929	26.7008	.0000
NPAE(2)	-1.3652	6.9645	.0083
NPAE(3)	-.6841	1.5503	.2131
Constant	3.547	61.0344	.0000

N=751, Chi-Squared=57.926, Significance=.0000

Table 5.30 displays a summary of all regressions for male midshipmen. PRTPAFA regressions are included in Table 5.25 through Table 5.29. APPENDIX A shows the regressions for MALE PUPAFA, CUPAFA, and RUNPAFA. This table shows that the PAE is highly significant in predicting performance on the PRT. When the PAE is divided into its individual four components, only Shuttle Run and

Armstrength are significant in predicting PRTPAFA. Both independent variables are highly significant, while Shuttle Run negatively correlates to performance on the PRT. As Shuttle Run time decreases, likelihood of scoring above 70 points on the PRT increases. As number of pullups performed increases, likelihood of scoring above 70 points on the PRT increases. When all independent variables were included in the regression, the same two variables (Shuttle Run and Armstrength) were statistically significant in predicting performance on the PRT.

Table 5.30: Summary of Significant Independent Variables for Male Model Midshipmen in Binary Logistic Regression Analysis

Males->DEP▶ IND▼	**PRTPAFA (PRT>70)**	**PUPAFA (PU>50)**	**CUPAFA (CU>68)**	**RUNPAFA (RUN<10.15)**
PAE Overall Score	**	**	**	**
PAE Individual Events	**-ShutRun **Arm strength	**Arm strength **Basket	**Arm strength	**-ShutRun *-Basket
All Independent Variables	*-ShutRun **Arm strength	**Arm strength *Basket #LongJump	**Arm strength	**-ShutRun
PAE Quartiles	**-NPAE1 **-NPAE2	**-NPAE1 -NPAE2 *-NPAE3	**-NPAE1 **-NPAE2 *-NPAE3	*-NPAE1

** Highly significant (<.01)
* Significant (.01-.05)
# Marginally significant (.05-.10)
- Negatively Correlates

PAE Quartiles
NPAE1 =Lowest male quartile in performance (0-25%: 0-190)
NPAE2=Third male quartile in performance (25-50%: 190-222)
NPAE3= Second male quartile in performance (50-75%: 222-256)
NPAE4=Top male quartile in performance, used as reference quartile

2. Female PRTPAFA Data

The regression to determine whether PAE performance predicts PRT performance began with the initial specification of the likelihood of passing the PRT as follows:

$$\mathbf{LN\ (P_{prtpafa} / (1\text{-}P_{prtpafa}))\ = B_0 + B_1 PAEoverallscore,}$$

Where $\mathbf{LN\ (P_{prtpafa} / (1\text{-}P_{prtpafa}))}$ = log of the odds of scoring 70 or greater on the PRT.

There were 138 cases used in this analysis. The result in Table 5.31 shows that the overall PAE score is statistically significant (.0497) in predicting overall PRT score pass or fail.

In order to determine if a better model is possible examining the individual PAE tests, the overall PAE was split into its four individual tests. The model specification with results is as follows:

$$\mathbf{LN\ (P_{prtpafa} / (1\text{-}\ P_{prtpafa}))\ = B_0 + B_1\ Armstrength\ Raw +\ B_2 Basketball\ Throw\ Raw}$$

$$\mathbf{+\ B_3 Longjump\ Raw + B_4\ Shuttlerun\ Raw,}$$

There were 138 females included in this analysis. As shown in Table 5.32, there were no significant independent variables among the four individual PAE events in predicting the likelihood of passing the PRT.

Table 5.31 Model: Female Likelihood of Passing PRT(PRTPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0136	3.8518	.0497
Constant	-.8273	.2780	.5980

N=138, Chi-squared= 4.231, Significance=.0397

Table 5.32 Model: Female Likelihood of Passing PRT(PRTPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	.0472	.9005	.3426
SHTLRU_R	.0352	.3694	.5433
BBTHRW_R	.0547	1.3382	.2473
ARMSTR_R	.0460	2.0386	.1534
Constant	-6.6767	1.4566	.2275

N=138, Chi-squared=7.693, Significance=.1035

In the following regression, all variables from Chapter III were added to determine the significant predictors of performance on a female midshipman scoring 70 or more on the PRT. The model specification with results is as follows:

$LN\ (P_{prtpafa} / (1 - P_{prtpafa})) = B_0 + B_1$ Armstrength Raw + B_2Basketball Throw Raw + B_3Longjump Raw + B_4 Shuttlerun Raw +B_5 Age +B_6 Height + B_7 Weight + B_8 Bodyfat +B_9 BMI +B_{10} Bluchip + B_{11} Recruit.

In Table 5.33 and 5.34 there were also no significant variables. Interestingly, the overall PAE score is a statistically significant predictor of the likelihood of passing the PRT, but the individual components are not statistically significant.

Table 5.33 Model: Female Likelihood of Passing PRT(PRTPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
LONGJP_R	.0582	.6821	.4089
SHTLRU_R	.0074	.0075	.9311
BBTHRW_R	.0131	.0543	.8157
ARMSTR_R	.0404	.7430	.3887
AGE	.6024	.4603	.4975
HEIGHT	-.4852	.0749	.7843
WEIGHT	.0661	.0253	.8737
BODYFAT	-.2431	1.5709	.2101
BMI	-.0108	.0000	.9965
BLUECHIP	.9597	.4414	.5065
RECRUIT	-.6879	.5846	.4445
Constant	14.5226	.0147	.9036

N=123, Chi-squared= 11.394, Significance=.4109

Table 5.34 Model: Female Likelihood of Passing the PRT(PRTPAFA) vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		4.5969	.2038
NPAE(1)	-1.6422	2.1309	.1444
NPAE(2)	-1.6422	2.1309	.1444
NPAE(3)	.1213	.0071	.9327
Constant	3.4339	11.4241	.0007

N=138, Chi-squared=6.086, Significance=.1075

Table 5.35 displays a summary of all regressions for female midshipmen. This table shows that the PAE is statistically significant in predicting performance on the PRT. When the PAE is divided into its individual four components, no individual components are significant in predicting PRTPAFA. However, Armstrength and Shuttle Run are significant in the individual portions of the PRT. Appendix B shows the regressions for FEMALE PUPAFA, CUPAFA, and RUNPAFA.

Table 5.35: Significant Independent Variables for Female Model Midshipmen in Binary Logistic Regressions

Males-DEP► IND▼	PRTPAFA (PRT>70)	PUPAFA (PU>27)	CUPAFA (CU>67)	RUNPAFA (RUN<12.01)
PAE Overall Score	*	*	**	*
PAE Individual Events		*Armstrength	*Armstrength	#-ShutRun
All Independent Variables		#Armstrength #LongJump #-Height	#Armstrength	#-ShutRun
PAE Quartiles		#-NPAE1		*-NPAE1

** Highly significant (<.01)
* Significant (.01-.05)
# Marginally significant (.05-.10)
- Negatively Correlates

PAE Quartiles
NPAE1=Lowest female quartile in performance (0-25%: 0-208)
NPAE2=Third female quartile in performance (25-50%: 208-246)
NPAE3=Second female quartile in performance (50-75%: 246-287)
NPAE4=Top female quartile in performance, used as reference quartile

D. MODEL ANALYSIS USING LINEAR REGRESSION

1. Male Midshipmen

The Predicted Male midshipmen database was used to test the following models created using linear regression and significant variables determined from the model database in Section C. Both groups, Model and Predicted, are statistically the same. Appendix C shows the morphological data, PAE data, and PRT data of the predicted database. The following linear regression was used to test the model that the PAE predicts performance on the PRT. Table 5.36 shows the results of the linear regression to test the predicted database.

Table 5.36: Male Model PAE Overall Score vs. PRT Overall Score

Model		Unstandardized Coefficients B	t	Sig.
1	(Constant)	62.606	38.378	.000
	PAE Overall Score	8.552E-02	12.026	.000

Dependent Variable: PRT score overall
N= 745, R-square=.162

In order to determine a male midshipman's overall PRT score using this model, one would multiply .08552 by the Overall PAE score and then add 62.606.

Table 5.37 shows a hypothetical score on the PAE and the corresponding hypothetical score on the PRT using the model above. This table is a good predictor for the group as a whole, but not a good predictor for an individual midshipman due to a low R-squared and a high t.

Table 5.37: Hypothetical Predicted Male Midshipman PRT Score and Corresponding PAE Score

PAE Score	PRT Score
0	66.882
50	71.158
100	73.296
150	75.434
200	79.71
250	83.986
300	88.262
350	92.538
400	96.814

In the following model for male midshipmen, the significant variables of the PAE, including Armstrength and Shuttle Run, were used to create a linear model to test the predicted database. Table 5.38 shows the data for the coefficients for the model. A negative coefficient for shuttle run in this model is logical because one would expect PRT score to decrease as shuttle run time increases.

Table 5.38: Male Model Significant Individual PAE Tests vs. PRT Overall Score

Model		Unstandardized Coefficients	t	Sig.
		B		
1	(Constant)	110.346	19.082	.000
	Shuttle Run Raw(seconds)	-.613	-6.583	.000
	Armstrength Raw(repetitions/seconds)	.753	11.236	.000

Dependent Variable: PRT Score overall
N=745, R-square=.250

Table 5.39 shows a hypothetical midshipman scoring below average, average, and above average on the PAE significant variables and the resulting PRT score.

Table 5.39: Predicted Male Midshipman PAE Score and Corresponding PRT Score

Armstrength (Pullup repetitions)	Shuttle Run (seconds)	PRT Score
0	**100**	49.046
2	**69.2**	69.452
8	**60.3**	79.41
25	**50.1**	98.461

2. Female Midshipmen

The Predicted Female midshipmen database was used to test the following models created using linear regression and significant variables determined from the model database in Section C. Both groups, Model and Predicted, are statistically the same. Appendix C shows the morphological data, PAE data, and PRT data of the predicted database. The following linear regression was used to test the model that the PAE predicts performance on the PRT for female plebes. Table 5.40 shows the results of the female model.

Table 5.40: Female Model PAE Overall Score vs. PRT Overall Score

Model		Unstandardized Coefficients	t	Sig.
		B		
1	(Constant)	59.819	15.756	.000
	PAE Overall Score	8.979E-02	6.074	.000

Dependent Variable: PRT Score overall
N=144, R-square=.207

Table 5.41 shows a hypothetical score on the PAE and the corresponding hypothetical score on the PRT using the female model above.

Table 5.41: Hypothetical Predicted Female Midshipman PAE Score and Corresponding PRT Score

PAE Score	PRT Score
0	59.819
50	64.3085
100	68.798
150	73.2875
200	77.777
250	82.2665
300	86.756
350	91.2455
400	95.735

No other linear model was developed to predict female performance on the PRT because there were no significant variables when all independent variables were included in the regression.

E. MODEL ANALYSIS USING LOGIT MARGINAL EFFECTS

1. Male Midshipmen

To illustrate the effects of the independent variables in a logistic regression, one must first calculate the marginal effects. For binary logistic regressions, the coefficients are the log of the odds of a "1" outcome for the dependent variable (PRTPAFA), holding constant the other variables. Since the coefficients are the log of the odds of the probability of scoring 70 points or more on the PRT, some additional calculations are undertaken to get at the marginal effects of the independent variables. This is a four-step process[4]:

(1) Calculate $Z = b_k * \text{X-bar}_k$, where:

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[4] As described by W. R. Bowman in "Dichotomous Dependent Variables and Regression Analysis Using SPSS, p.14.

b_k = logit coefficient for independent variable "k" and

X-bar $_k$ = intercept and mean values of independent variables

(2) Calculate $P(Y=1)=1/(1+e^{-z})$

(3) Calculate $P(Y=0) = 1 - P(Y=1)$

Calculate "delta" (the marginal effect) = $b_k * [P(Y=1)*(1-P(Y=1)]$, or

"marginal effect" = $b_k * (P*(1-P))$

Using Microsoft Excel, the calculations are performed with the below listed results in Table 5.42. Only significant variables are included.

Table 5.42: Predicted Effects of Independent Variables for Male Predicted Midshipmen Passing PRT

VARIABLE	x bar	LOGIT	X*LOGIT	MARGINAL
				LOGIT*P(1-P)
INTRCPT	1	9.5027	9.5027	
ARMSTR_R	10.2162	0.2359	2.4100016	**0.013328**
SHUTRUN	59.2701	-0.1546	-9.1631575	**-0.00873**
			Z=S(X*LOGIT)	
			2.7495441	
			P=1/(1+e^-Z)	
			0.939888	

The marginal effects are evaluated for the final specification of the MALE PRTPAFA model. The marginal effects are the impact each independent variable has on the outcome, holding other variables constant. Each pullup performed in Armstrength Raw increases the probability of scoring 70 or more on the PRT by 1.3%. Each second decrease on the Shuttle Run time increases the probability of scoring a 70 or more on the PRT by .8%.

Marginal effects were used to measure overall PAE score and probability of passing the PRT. Overall PAE score was significant for males in predicting PRT score so

this was examined to determine the effect of changing the PAE score on a male midshipman's probability of passing the PRT. When the male midshipman's PAE score decreases by two standard deviations, his probability of passing the PRT decreases from 92.4% to 58.8%. When PAE score increases by two standard deviations, probability of passing the PRT increases from 92.4% to 99.1%.

Table 5.43: Predicted Effect of Change in PAE Overall Score on Probability of Scoring over 70 on the PRT for Male Predicted Midshipmen

Midshipman Based on PAE Score	PAE Score (0-400)	%Probability of Scoring 70 or more on the PRT
Well Below Average(-2SD)	131.9586	58.7575
Below Average(-1 SD)	178.6335	80.06507
Average	**225.3084**	**92.4211**
Above average(+1SD)	271.9833	97.2735
Well Above Average(+2SD)	318.6582	99.0511

Sample scores for Armstrength Raw and Shuttle Run Raw were used to determine probabilities of scoring 70 or more points on the PRT. Sample data both one and two standard deviations above and below the average for Male Predicted midshipmen was used. Table 5.44 shows that when a midshipman performs two standard deviations above the average in pullups keeping all other independent variables constant, his chance of scoring over 70 on the PRT rises from 94.0% to 99.4%. When the sample midshipman performs two standard deviations below the average on pullups, his percent probability of scoring 70 or more on the PRT decreases to 58.4%.

When performing these calculations, the mean value of the other significant variable, shuttle run, is held constant. It is recognized that as the number of pullups increases, shuttle run time decreases. However, Table 5.44 effectively conveys the change in the likelihood of passing the PRT as the table changes in the manner described.

One significant variable remains constant at the mean performance level while the other varies by a standard deviation from the mean performance level of the midshipmen in the study. This applies to all tables predicting the effects of significant independent variables on the probability of scoring over 70 on the PRT in Section E.

Table 5.44: Predicted Effect of Armstrength Score on Probability of Scoring over 70 on the PRT for Male Predicted Midshipmen

Midshipman Based on Armstrength Raw	Armstrength Raw (Pullups Performed)	%Probability of Scoring 70 or more on the PRT
Well Below Average(-2SD)	0	58.4079
Below Average(-1 SD)	5.0259	82.1296
Average	**10.2162**	**93.9888**
Above average(+1SD)	15.1533	98.0434
Well Above Average(+2SD)	20.217	99.3993

In Table 5.45, scores for Shuttle Run Raw were used to determine the probabilities of scoring 70 or more points on the PRT. Sample data both one and two standard deviations above and below the average for Male Predicted midshipmen was used. In Table 5.45, when a midshipman performs two standard deviations above the average on the shuttle run keeping all other independent variables constant, his chance of scoring 70 or more on the PRT rises from 94.0% to 99.4%. When the sample midshipman performs two standard deviations below the average on the shuttle run, his percent probability of scoring 70 or more on the PRT decreases to 82.5%.

Table 5.46 shows the marginal effects of a midshipman who performs above and below average in Armstrength and Shuttle Run. A sample midshipman who performs two standard deviations below the average in Armstrength and Shuttle Run has a 29.8% percent chance of scoring over 70 on the PRT. A midshipman who scores two standard

deviations above the average in Armstrength and Shuttle Run has a 99.8% chance of scoring 70 or more on the PRT.

Table 5.45: Predicted Effect of Shuttle Run Time on Probability of Scoring over 70 on the PRT for Male Predicted Midshipmen

Midshipman Based on Shuttle Run Raw	Shuttle Run Raw Time (seconds)	Percent Probability of Scoring 70 or more on the PRT
Well Below Average(-2SD)	67.017	82.5184
Below Average(-1 SD)	63.154	89.5584
Average	**59.2701**	**93.9888**
Above average (+1 SD)	55.428	96.5892
Well Above Average(+2 SD)	51.565	98.0937

Table 5.46: Combined Predicted Effect of Shuttle Run Time and Armstrength Raw on Probability of Scoring over 70 on the PRT for Male Predicted Midshipmen

Midshipman Based on Shuttle Run Time and Armstrength	Shuttle Run Raw Time (Seconds)	Armstrength Raw (Pullups Performed)	%Probability of Scoring 70 or more on PRT
Well Below Average(-2 SD)	67.017	0	29.7731
Below Average(-1 SD)	63.154	5.0259	71.5999
Average	**59.2701**	**10.2162**	**93.9888**
Above Average(+1SD)	55.428	15.1533	98.9102
Well Above Average(+2SD)	51.565	20.217	99.8167

2. Female Midshipmen

There were no significant independent variables for females to conduct the marginal effect analysis with Armstrength and Shuttle Run. Instead, marginal effects were used to measure overall PAE score and probability of passing the PRT. Overall PAE score was significant for females in predicting PRT score so this was examined to determine the effect of changing the PAE score on a female midshipman's probability of passing the PRT. Table 5.47 shows that when the female midshipman's PAE score decreases by two standard deviations, her probability of passing the PRT decreases from 92.9% to 77.2%. When PAE score increases by two standard deviations, probability of passing the PRT increases from 92.9% to 98.1%.

Table 5.47: Marginal Effect of Change in PAE Overall Score on Probability of Scoring over 70 on the PRT for Female Predicted Midshipmen

Midshipman Based on PAE Score	PAE Score (0-400)	%Probability of Scoring 70 or more on the PRT
Well Below Average (-2 SD)	150.3446	77.1603
Below Average (-1 SD)	199.9818	86.9035
Average	**249.619**	**92.8742**
Above average (+1SD)	299.2562	96.2406
Well Above Average (+2SD)	348.8934	98.05

VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This chapter discusses the results of the hypotheses and questions presented in Chapter III. The hypotheses will be summarized and the questions will be answered by reviewing the cross tabulations, frequencies, linear, and logit regressions. This summary will be followed by the conclusions. The final section of the Chapter will present questions that may lead to further research and analysis.

B. HYPOTHESES RESULTS

1. Hypothesis 1:

The overall PAE score, determined from the test administered to applicants during the US Naval Academy admissions process, predicts performance on the overall PRT score of the first PRT of the fall semester for male and female plebes. Logit and linear regression analysis show that a midshipman's overall PAE score is statistically significant in predicting the ability to score 70 or more points on the PRT. Female results are less significant than male results. This may be due to the lower number of subjects in the database as well as physiological differences.

2. Hypothesis 2:

Armstrength (Pullups for males, Flexed Arm Hang for females) and Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, individually predict performance on the first PRT of the fall semester for male and female plebes. Longjump and Basketball Throw do not individually predict performance on the overall PRT score of the first PRT of the fall semester for male and female plebes.

Shuttle Run and Armstrength predict overall PRT performance for male midshipmen based on linear and logit regression analysis. Shuttle Run and Armstrength are not statistically significant in predicting overall PRT performance for female midshipmen.

3. Hypothesis 3:

Armstrength (Pullups for males, Flexed Arm Hang for females), administered to applicants as part of the PAE during the US Naval Academy admissions process, individually predicts performance on the curlup portion of the first PRT of the fall semester for male and female plebes. Armstrength is highly statistically significant in predicting male curlup performance while Armstrength is only statistically significant in predicting female curlup performance. Shuttle Run, Longjump, and Basketball Throw do not individually predict performance on the curlup portion of the first PRT of the fall semester for male and female plebes.

4. Hypothesis 4:

Armstrength and Basketball Throw individually are highly statistically significant in predicting performance on the pushup portion of the first PRT of the fall semester for male plebes. Shuttle Run and Longjump do not individually predict performance on the pushup portion of the first PRT of the fall semester for male plebes.

Armstrength and Longjump individually are marginally statistically significant in predicting performance on the pushup portion of the first PRT of the fall semester for female plebes. Height is marginally significant and negatively correlates to performance

on pushups for females. Shuttle Run and Basketball Throw do not individually predict performance on the pushup portion of the first PRT of the fall semester for female plebes.

5. Hypothesis 5:

Shuttle Run, administered to applicants as part of the PAE during the US Naval Academy admissions process, is highly statistically significant and negatively correlates to performance on the 1.5-mile run portion of the first PRT of the fall semester for male plebes. As Shuttle Run time decreases, probability of running the 1.5-mile run in faster than 10.15 minutes increases. Basketball Throw is also statistically significant and negatively correlates to performance on the 1.5-mile run for male plebes. The further a male plebe can throw the basketball, the more likely he is to fail to run a time faster than 10.15 minutes in the 1.5-mile run. Armstrength and Longjump do not individually predict performance on the 1.5-mile run portion of the first PRT of the fall semester for male plebes. Shuttle Run is marginally significant and negatively correlates to 1.5-mile run performance for female plebes.

6. Hypothesis 6:

Age, weight, Body fat percentage and BMI do not predict performance on the overall PRT score and individual PRT components of the first PRT of the fall semester for male and female plebes. Height is the only morphological variable that is statistically significant in predicting female performance in pushups. As female midshipmen become taller, their likelihood of accomplishing 27 pushups in 2 minutes decreases.

7. Hypothesis 7:

There is no evidence from this study that male and female plebe Recruited and Blue Chip Athletes perform better on the overall PRT score and individual components

of the first PRT of the fall semester than non-Recruited or non-Blue Chip athlete midshipmen. Neither independent variable was significant in predicting performance on the PRT.

C. DISCUSSION

The data and analysis presented in this research indicates that the overall PAE score predicts only a small percentage of performance on the PRT. Based on the data, more effective tests are available to predict performance on the PRT. The best test to predict performance on the PRT would be the PRT itself, administered as the PAE. Further analysis would be needed, however, to determine if the PAE provides information about midshipman performance that is fully captured by the PRT. Based on the data presented in this thesis, a secondary option that would better predict performance on the PRT would be a PAE consisting of Armstrength and Shuttle Run. These tests were significant in predicting male and female plebe performance on the pushups, curlups, and 1.5-mile run, although the tests were less significant for females. Basketball throw and Longjump could be eliminated from the PAE without any degradation in predictability of PRT performance. This is not surprising considering the history of the PAE.

A different scoring scale would be another option to create a more meaningful PAE score. Multiplying Armstrength score by 4, multiplying Shuttle Run score by 2, and multiplying Longjump and Basketball Throw scores by 1 would give Armstrength and Shuttle Run the added emphasis that they warrant based on this study. Based on scaled scoring, a PAE with a possible 800 point maximum would consist of 50% Armstrength, 25% Shuttle Run, 12.5% Longjump, and 12.5% Basketball Throw. This way the

increased importance of the Armstrength test as shown with marginal effects would count more in the PAE overall score. This would also allow the format of the PAE to remain the same while only changing the scoring system.

The data presented in this thesis are too limited to predict specific individual midshipman performance on the PRT, but this data may be used to predict the likelihood that a person will have difficulty performing up to average midshipman standards based on the PAE score and its significant individual components, namely Armstrength and Shuttle Run.

The data in this thesis should be used as a tool by faculty and staff to identify those candidates and midshipmen who may have problems passing certain portions of the PRT. They may be able to help those candidates and midshipmen better prepare to succeed on this test.

D. RECOMMENDATIONS FOR FURTHER RESEARCH

1. This study attempted to explain whether the PAE taken during the candidate's senior year of high school can be used to predict the first PRT of fall semester plebe year. Anywhere from 4 months to 12 months may have passed between the PAE and the PRT. In a follow up study, one could administer the PAE to the plebe class immediately after reporting to the Naval Academy plebe summer and then administer the PRT the following week. Fitness level would be the same for the PAE and the PRT.

2. Female data were less significant than male data in almost every regression in this study. There are many reasons why this may have occurred. In order to determine a PAE that would better predict performance on the PRT for females, more female data

sets need to be examined. Another reason for this may be that the PAE is a better predictor of male performance on the PRT than female performance on the PRT.

3. One reason that midshipmen leave the Naval Academy is failure to pass the PRT. A study to determine the number of midshipmen who have left the Naval Academy for PRT failures, the reasons for the PRT failures, and their PAE scores prior to failing would be an interesting analysis.

4. There are many opinions on the purpose of the PAE.[5] An interesting study would examine the PAE as a predictor of Overall Order of Merit, Military Order of Merit, Performance grades, or grades in the Physical Education program.

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[5] During a conference attended by this author, a member of the USMA Physical Education department explained his belief that the PAE should be used to determine success in the USMA PE program, not just on the semi-annual fitness test.

APPENDIX A: MALE REGRESSIONS ANALYSIS

Male PUPAFA Data

Regressions were analyzed for each of the individual tests on the PRT in the same fashion that the overall test score was analyzed. The bottom 10 % of male midshipmen could not do more than 50 pushups on the PRT. This was used as the cutoff for the dependent variable in the following regressions. Males who performed more than 50 pushups received a 1 in the binary logistic regression, while those who did 50 pushups or less received a 0. The results of PUPAFA and PAE Overall Score are shown in Table A-1. PAE Overall Score is highly significant (.0000).

Table A-2 shows PUPAFA and the individual PAE scores. Armstrength_Raw is highly significant while Basketballthrow_Raw is marginally significant in predicting the ability to perform more than 50 pushups on the PRT. Longjump and Shuttle Run are not statistically significant in predicting performance on the pushup portion of the PRT.

Table A-3 shows the significant individual PAE independent variables, which predict performance on the pushup portion of the PRT. Armstrength_Raw is highly significant(.0000), while Basketballthrow_Raw is also highly significant(.0063).

Table A-1 Model: Male Likelihood of Performing Above the Bottom 10% in Pushups(PUPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0240	59.4708	.0000
Constant	-2.9581	23.5762	.0000

N=752, Chi-squared=76.083, Significance=.0000

Table A-2 Initial Model: Male Likelihood of Performing above the Bottom 10% in Pushups (PUPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	.0219	1.4782.	.2241
SHTLRU_R	-.0418	1.0350	.3090
BBTHRW_R	.0215	3.7337	.0533
ARMSTR_R	.2607	44.6678	.0000
Constan	-.9730	.0731	.7868

N= 752, Chi-squared= 107.504, Significance=.0000

Table A-3 Alternate Model: Male Likelihood of Performing above the Bottom 10% in Pushups vs. Significant PAE Individual Events

Variable	B	Wald	Sig
BBTHRW_R	.0288	7.4692	.0063
ARMSTR_R	.2896	61.7445	.0000
Constant	-2.1628	9.2131	.0024

N=752, Chi-squared=103.128, Significance=.0000

All independent variables were placed in the next logistic regression, the initial model for PUPAFA. The results are shown in Table A-4. Significant variables included Armstrength_Raw and Basketballthrow_Raw as highly significant, Longjump_Raw as significant and age as marginally significant.

Only the independent variables which were significant in the initial PUPAFA model were included in this regression. The data in Table A-5shows that Armstrength_Raw remained highly significant, Basketballthrow_Raw was significant, Longjump_Raw became marginally significant, and age became less than marginally significant.

In the next regression, PUPAFA was analyzed using the PAE quartiles scores. Results displayed in Table A-6 show that the PAE bottom (fourth) quartile score is highly significant (.0000) in predicting pushups performed, while in the third quartile the PAE is marginally significant(.0605) and in the second quartile, the PAE is significant (.0390). The top quartile was used as a reference quartile.

Table A-4 Initial Model: Male Likelihood of Performing above the Bottom 10% in Pushups vs. All Independent Variables

Variable	B	Wald	Sig
AGE	.6280	3.6628	.0556
HEIGHT	-.2728	.6607	.4163
WEIGHT	.0215	.1004	.7513
BODYFAT	-.0393	.7511	.3861
BMI	-.1323	.0688	.7931
LONGJP_R	.0401	4.1651	.0413
SHTLRU_R	-.0116	.0656	.7978
BBTHRW_R	.0397	8.9580	.0028
ARMSTR_R	.2282	28.5413	.0000
BLUECHIP	.0971	.0274	.8686
RECRUIT	-.3351	.4916	.4832
Constant	2.6270	.0107	.9176

N=682, Chi-squared=120.177, Significance=.0000

Table A-5 Alternate Model: Male Likelihood of Performing above the Bottom 10% in Pushups vs. Significant Independent Variables

Variable	B	Wald	Sig
LONGJP_R	.0306	3.3114	.0688
BBTHRW_R	.0222	4.0850	.0433
ARMSTR_R	.2698	50.2603	.0000
AGE	.4560	2.2253	.1358
Constant	-12.6341	4.8065	.0284

N=749, Chi-squared=108.710, Significance=.0000

Table A-6 Model: Male Likelihood of Performing More Than 50 Pushups(PUPAFA) on the PRT vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		59.2625	.0000
NPAE(1)	-2.6491	30.3914	.0000
NPAE(2)	-1.0088	3.5240	.0605
NPAE(3)	-1.0798	4.2624	.0390
Constant	3.5437	61.0344	.0000

N= 752, Chi-squared=67.752, Significance=.0000

Male CUPAFA Data

The bottom 10% of male midshipmen could not do more than 68 curlups on the PRT. This was used as the cutoff for the dependent variable, CUPAFA, in the following

regressions. Males who performed more than 68 curlups received a 1 in the binary logistic regression, while those who did 68 curlups or less received a 0.

In Table A-7, the results show that PAE Overall Score is highly significant in predicting a male midshipman's ability to perform 68 curlups.

In Table A-8, the results of CUPAFA regressed against the individual PAE events are shown. Armstrength_Raw is the only statistically significant variable (.0000) of the four PAE events in predicting a male midshipman's ability to perform more than 68 curlups.

Table A-9 shows the significant individual PAE event, Armstrength_Raw as a predictor of CUPAFA. Armstrength_Raw is again highly significant (.0000) in predicting a male midshipman's ability to perform more than 68 curlups.

Table A-7 Model: Male Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0177	33.9492	.0000
Constant	-1.5079	6.1047	.0135

N=752, Chi-squared=39.423, Significance=.0000

Table A-8 Initial Model: Male Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	.0087	.2228	.6369
SHTLRU_R	-.0566	1.7786	.1823
BBTHRW_R	.0120	1.1060	.2930
ARMSTR_R	.1761	23.7182	.0000
Constant	2.5156	.4666	.4945

N=749, Chi-squared=53.779, Significance=.0000

Table A-9 Alternate Model: Male Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) vs. Significant PAE Individual Events

Variable	B	Wald	Sig
ARMSTR_R	.2047	36.9710	.0000
Constant	.4758	3.1598	.0755

N=752, Chi-squared=47.799, Significance=.0000

Table A-10 shows results of the regression using all independent variables to evaluate CUPAFA. The only significant variable is Armstrength_Raw (.0000). No alternate regression was conducted on CUPAFA and Armstrength_Raw because this is the same regression with results shown in Table A-9.

In the next regression, CUPAFA was analyzed using the PAE quartiles scores. Results displayed in Table A-11 show that the PAE bottom (fourth) quartile score is highly significant (.0000) in predicting curlups performed, while in the third quartile the PAE is highly significant(.0047) and in the second quartile, the PAE is significant (.0390). The top quartile was used as a reference quartile.

Table A-10 Model: Male Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
AGE	-.2727	.6603	.4165
HEIGHT	.2799	.7315	.3924
WEIGHT	-.0448	.4627	.4964
BODYFAT	-.0281	.3708	.5426
BMI	.2699	.3190	.5722
LONGJP_R	-.0031	.0229	.8797
SHTLRU_R	-.0251	.2864	.5925
BBTHRW_R	.0123	.8189	.3655
ARMSTR_R	.1778	18.6612	.0000
BLUECHIP	-.8508	1.0340	.3092
RECRUIT	1.1959	2.4839	.1150
Constant	-11.7068	.2316	.6304

N=752, Chi-squared=44.761, Significance=.0000

Table A-11 Model: Male Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) on the PRT vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		27.5218	.0000
NPAE(1)	-2.3663	19.4178	.0000
NPAE(2)	-1.5936	8.0000	.0047
NPAE(3)	-1.2384	4.6822	.0305
Constant	3.7721	55.6712	.0000

N=752, Chi-squared=34.729, Significance=.0000

Male RUNPAFA Data

The bottom 10% of male midshipmen could not run the 1.5-mile run in a time faster than 10.15 minutes on the PRT. This was used as the cutoff for the dependent variable, RUNPAFA, in the following regressions. Males who performed the 1.5-mile run in a time faster than 10.15 minutes received a 1 in the binary logistic regression, while those who ran slower than 10.15 minutes received a 0.

In Table A-12, the results show that PAE Overall Score is highly significant (.0008) in predicting a male midshipman's ability to perform the 1.5-mile run in faster than 10.15 minutes.

In Table A-13, the results of RUNPAFA regressed against the individual PAE events are shown. Shuttle Run is highly significant (.0000) in predicting RUNPAFA, while Basketballthrow_Raw is negatively significant (.0390) in predicting performance on the 1.5-mile run. When the distance that the basketball is thrown increases, the likelihood of running faster than 10.15 minutes on the 1.5-mile run decreases.

Table A-14 shows the significant individual PAE events, Shuttlerun_Raw and Basketballthrow_Raw. Results are almost exactly the same for the two significant variables as in Table 5.42.

Table A-12 Model: Male Likelihood of Performing Above the Bottom 10% in the 1.5-Mile Run (RUNPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0089	11.3549	.0008
Constant	.1920	.1159	.7335

N=752, Chi-squared=12.002, Significance=.0005

Table A-13 Initial Model: Male Likelihood of Performing Above the Bottom 10% in the 1.5-Mile Run (RUNPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	-.0130	.5835	.4449
SHTLRU_R	-.2312	30.6607	.0000
BBTHRW_R	-.0229	4.2622	.0390
ARMSTR_R	.0209	.5904	.4423
Constant	18.5325	27.3038	.0000

N=749, Chi-squared=43.083, Significance=.0000

Table A-14 Alternate Model: Male Likelihood of Performing Above the Bottom 10% in the 1.5-Mile Run (RUNPAFA) vs. Significant PAE Individual Events

Variable	B	Wald	Sig
SHTLRU_R	-.2292	38.9129	.0000
BBTHRW_R	-.0251	5.3805	.0204
Constant	17.5445	47.3866	.0000

N=752, Chi-squared=42.217, Significance=.0000

Table A-15 shows results of the regression using all independent variables to evaluate RUNPAFA. The only significant variable is Shuttlerun_Raw (.0007). Basketballthrow_Raw was no longer significant when included with all other independent variables. In Table A-16, only the significant independent variable, Shuttlerun_Raw was regressed and found to be highly significant (.0000). It is interesting to note that Basketballthrow_Raw is not significant when all independent variables are included (Table A-15) but it is significant when only the four individual PAE events are included (Table A-13).

In the next regression, RUPAFA was analyzed using the PAE quartiles scores. Results displayed in Table A-17 show that the PAE bottom (fourth) quartile score is

significant (.0121) in predicting ability to run the 1.5-mile run faster than 10.15 minutes, while in the third quartile and the second quartile, the PAE quartile score is not significant in predicting run performance. The top quartile was used as a reference quartile.

Table A-15 Initial Model: Male Likelihood of Performing Above the Bottom 10% in the 1.5-Mile Run (RUNPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
SHTLRU_R	-.1579	11.5007	.0007
BBTHRW_R	-.0057	.1763	.6746
AGE	.2981	.8191	.3654
HEIGHT	.5158	2.3645	.1241
WEIGHT	-.0844	1.6193	.2032
BODYFAT	.0025	.0029	.9569
BMI	.4002	.7094	.3996
LONGJP_R	-.0199	.9638	.3262
ARMSTR_R	.0211	.4209	.5165
BLUECHIP	-.7254	1.3704	.2417
RECRUIT	.4663	.6739	.4117
Constant	-23.2909	.8934	.3446

N=682, Chi-squared=57.871, Significance=.0000

Table A-16 Alternate Model: Male Likelihood of Performing Above the Bottom 10% in the 1.5-Mile Run (RUNPAFA) vs. Significant Variables

Variable	B	Wald	Sig
SHTLRU_R	-.2053	33.9505	.0000
Constant	14.4519	45.0849	.0000

N=752, Chi-squared=36.775, Significance=.0000

Table A-17 Model: Male Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run(RUNPAFA) on the PRT vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		14.9553	.0019
NPAE(1)	-.8077	6.2994	.0121
NPAE(2)	-.0730	.0399	.8417
NPAE(3)	.3720	.9175	.3381
Constant	2.3150	78.0404	.0000

N=752, Chi-squared=14.864, significance=.0019

APPENDIX B: FEMALE REGRESSION ANALYSIS

Female PUPAFA

Table B-1 shows that Overall PAE score is significant (.0184) in predicting performance on the pushup portion of the PRT for female midshipmen. When the PAE is split into its individual components, Armstrength_Raw is statistically significant (.0215) in predicting the likelihood of a female midshipman performing more than 27 pushups. In Tables B-4 and B-5 using all independent variables, Armstrength_Raw (.0552), Longjump_Raw (.0621) and height (.0003) are statistically significant. This is the only regression where height, weight, body mass index, body fat, or age was significant in predicting performance on any portion of the PRT for males or females.

There is evidence of mulitcollinearity in the FEMALE PUPAFA regression using all significant independent variables. When the significant variables, height, weight, BMI, body fat and age are regressed in the initial model, there is evidence that weight, body fat, and BMI are highly correlated. Body fat and BMI were eliminated from the initial model for this reason.

In the PAE quartile regression, only the bottom quartile is marginally significant in predicting the likelihood of performing 27 pushups.

Table B-1 Model: Female Likelihood of Performing Above the Bottom 10% in Pushups (PUPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0146	5.5585	.0184
Constant	-1.1626	.7208	.3959

N=148, Chi squared=6.241, Significance=.0125

Table B-2 Initial Model: Female Likelihood of Performing Above the Bottom 10% in Pushups (PUPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
SHTLRU_R	-.0066	.0159	.8998
BBTHRW_R	.0125	.0950	.7579
ARMSTR_R	.0661	3.7351	.0533
LONGJP_R	.0405	.7537	.3853
Constant	-2.3975	.2087	.6478

N=148, Chi squared=9.444, Significance=.0509

Table B-3 Alternate Model: Female Likelihood of Performing Above the Bottom 10% in Pushups (PUPAFA) vs. Significant PAE Individual Events

Variable	B	Wald	Sig
ARMSTR_R	.0755	5.2898	.0215
Constant	.3769	.2656	.6063

N=148, Chi-squared=7.873, Significance=.0050

Table B-4 Initial Model: Female Likelihood of Performing Above the Bottom 10% in Pushups (PUPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
LONGJP_R	.1228	3.4803	.0621
SHTLRU_R	.0529	.4842	.4865
BBTHRW_R	.0204	.1952	.6587
ARMSTR_R	.0718	3.6773	.0552
BMI	.1818	1.3497	.2453
BLUECHIP	1.9343	2.5547	.1100
RECRUIT	-.1021	.0171	.8959
HEIGHT	-.7085	13.3468	.0003
Constant	29.5186	5.8565	.0155

N=137, Chi-squared=32.721, Significance=.0001

Table B-5 Alternate Model: Female Likelihood of Performing Above the Bottom 10% in Pushups (PUPAFA) vs. All Significant Independent Variables

Variable	B	Wald	Sig
LONGJP_R	.0987	3.9677	.0464
ARMSTR_R	.0506	2.4498	.1175
HEIGHT	-.4798	12.6053	.0004
Constant	25.4670	8.9663	.0027

N=145, Chi-squared=25.010, Significance=.0000

Table B-6 Model: Female Likelihood of Performing Above the Bottom 10% in Pushups(PUPAFA) vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		4.6007	.2035
NPAE(1)	-1.8852	2.9532	.0857
NPAE(2)	-1.6093	2.0516	.1520
NPAE(3)	-.6034	.2335	.6290
Constant	3.4656	11.6477	.0006

N=148, Chi-squared=5.793, Significance=.1221

Female CUPAFA

The PAE is highly statistically significant (.0021) in predicting a female midshipman's likelihood of performing more than 67 curlups. This is the only portion of the PRT where the Overall PAE score is highly statistically significant.

In Tables B-8 and B-9, when the PAE is split into individual tests, only the Armstrength_Raw is statistically significant (.0365) in predicting PUPAFA for female midshipmen in this study. Longjump_Raw, Shuttlerun_Raw, and Basketballthrow_Raw are not statistically significant in predicting whether or not a female midshipman will perform more than 67 curlups.

When Female CUPAFA is regressed against all independent variables in Table B-10, Armstrength_Raw (.0574) is marginally statistically significant.

In the CUPAFA regression shown in Table B-11, using the PAE quartiles, none of the PAE quartiles is significant in predicting performance on the PRT.

Table B-7 Model: Female Likelihood of Performing Above the Bottom 10% in Curlups (CUPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0204	9.4776	.0021
Constant	-2.4649	3.0549	.0805

N=148, Chi-squared=11.661, Significance=.0006

Table B-8 Model: Female Likelihood of Performing Above the Bottom 10% in Curlups (CUPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
LONGJP_R	.0385	.6547	.4184
SHTLRU_R	-.0175	.1126	.7372
BBTHRW_R	.0504	1.3519	.2450
ARMSTR_R	.0767	4.3715	.0365
Constant	-3.1464	.3586	.5493

N=148, Chi-squared=14.609, Significance=.0006

Table B-9 Model: Female Likelihood of Performing Above the Bottom 10% in Curlups (CUPAFA) vs. Significant PAE Individual Events

Variable	B	Wald	Sig
ARMSTR_R	.0883	6.4821	.0109
Constant	.0411	.0031	.9559

N=148, Chi-squared=10.273, Significance=.0014

Table B-10 Model: Female Likelihood of Performing Above the Bottom 10% in Curlups (CUPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
LONGJP_R	.0446	.4986	.4801
SHTLRU_R	-.0524	.6613	.4161
BBTHRW_R	.0413	.6941	.4048
ARMSTR_R	.1057	3.6110	.0574
AGE	-.0718	.0104	.9188
HEIGHT	.7707	.5193	.4711
WEIGHT	-.1957	.6165	.4324
BODYFAT	-.1575	1.2483	.2639
BMI	1.5031	.9763	.3231
BLUECHIP	.0078	.0000	.9947
RECRUIT	-.4324	.3392	.5603
Constant	-53.2193	.5373	.4635

N=133, Chi-squared=18.884, Significance=.0632

In Table B-12, RUNPAFA is regressed against the Overall PAE score and determined to be statistically significant in predicting female midshipman performance. When the PAE is split into its individual components, Shuttlerun_Raw is highly statistically significant (.0063), shown in Table B-13. Armstrength_Raw was included

Table B.11 Model: Female Likelihood of Performing Above the Bottom 10% in Curlups(CUPAFA) vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		3.4415	.3284
NPAE(1)	-8.9343	.0976	.7547
NPAE(2)	-8.0926	.0801	.7772
NPAE(3)	-7.7751	.0739	.7857
Constant	10.2028	.1273	.7212

N=148, Chi-squared=12.062, Significance=.063

with Shuttlerun_Raw in the Alternate Model in Table B-14 because it was almost marginally significant (.1183). When all independent variables were examined in the initial model (Table B-15), Shuttlerun_Raw, height, weight, BMI, and Recruited Athlete were all significant. When these five variables were regressed in an alternate model (Table B-16), only Shuttlerun_Raw remained statistically significant. This shows evidence of multicollinearity. When PAE quartiles were examined in Table B-17, only the lowest PAE quartiles was significant in predicting performance on the 1.5-mile run for female midshipmen.

Table B-12 Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run (RUNPAFA) vs. PAE Overall Score

Variable	B	Wald	Sig
PAE	.0128	5.7231	.0167
Constant	-1.1014	.8293	.3625

N=149, Chi-squared=6.282, Significance=.0122

Table B-13 Initial Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run (RUNPAFA) vs. PAE Individual Events

Variable	B	Wald	Sig
ARMSTR_R	.0388	2.4041	.1210
LONGJP_R	-.0127	.0764	.7823
SHTLRU_R	-.1431	7.4679	.0063
BBTHRW_R	-.0312	.7239	.3949
Constant	12.9292	5.2226	.0223

N=149, Chi-squared=15.783, Significance=.0033

Table B-14 Alternate Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run (RUNPAFA) vs. Significant PAE Individual Events

Variable	B	Wald	Sig
ARMSTR_R	.0382	2.4392	.1183
SHTLRU_R	-.1279	7.2210	.0072
Constant	9.7486	7.6925	.0055

N=149, Chi=squared=14.517, Significance=.0007

Table B-15 Initial Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run (RUNPAFA) vs. All Independent Variables

Variable	B	Wald	Sig
LONGJP_R	-.0152	.0732	.7867
SHTLRU_R	-.1766	7.8178	.0052
BBTHRW_R	-.0305	.4394	.5074
ARMSTR_R	.0142	.2261	.6345
AGE	.5339	.7565	.3844
HEIGHT	2.0671	3.2770	.0703
WEIGHT	-.5066	3.7285	.0535
BODYFAT	-.1323	1.2311	.2672
BMI	2.9705	3.5591	.0592
BLUECHIP	1.2340	1.4058	.2358
RECRUIT	-1.2202	3.2724	.0705
Constant	-122.400	2.7069	.0999

N=134, Chi-squared= 30.207, Significance=.0015

Table B-16 Alternate Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run (RUNPAFA) vs. Significant Independent Variables

Variable	B	Wald	Sig
SHTLRU_R	-.1442	8.1684	.0043
HEIGHT	.8937	.8998	.3428
WEIGHT	-.2257	1.1376	.2862
BMI	1.1468	.8280	.3628
RECRUIT	-.6815	1.4093	.2352
Constant	-41.0239	.4553	.4998

N=134, Chi-squared= 15.106, Significance=.0013

Table B-17 Model: Female Likelihood of Performing Above the Bottom 10% in 1.5-Mile Run(RUNPAFA) vs. PAE Quartiles

Variable	B	Wald	Sig
NPAE		4.5870	.2047
NPAE(1)	-2.1971	4.1136	.0425
NPAE(2)	-1.5786	1.9754	.1599
NPAE(3)	-1.6093	2.0516	.1520
Constant	3.4656	11.6477	.0006

N=149, Chi-squared=6.498, Significance=.0897

APPENDIX C: MALE AND FEMALE DATA FOR PREDICTED DATA SETS

Tables C-1, C-2, and C-3 show the Male Predicted data set including minimum, maximum and mean scores. This data set was used to test the model derived in Chapter V.

Table C-1: Male PREDICTED Morphological Data

Morphological Data Characterization for Male PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years on July 1 of Plebe Yr	782	16.89	19.00	18.1428	.3964
height(inches)	767	61.00	80.00	70.5658	2.8020
Weight(pounds)	730	120	262	169.76	25.21
Body Fat Percentage	755	2	28	12.50	4.56
Body Mass Index	730	16.48	36.91	23.9317	2.9021
Valid N (listwise)	718				

Table C-2: Male PREDICTED PRT Raw Data

Raw PRT Data for Male PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Pushups (number)	748	35	109	73.55	17.43
Curlups (number)	748	45	135	86.21	13.08
PRT Run Time (minutes)	749	7.60	14.53	9.2933	.6868
PRT score (overall)	748	55.00	99.90	81.2117	10.2429
Valid N (listwise)	748				

Table C-3: Male Raw and Scaled PAE Data for Male PREDICTED Database

Raw and Scaled PAE Data for Male PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Longjump Raw (inches)	777	69	122	94.01	8.58
Longjump Score	777	16.07	100.00	61.4320	18.2793
Shuttle Run Raw(seconds)	777	46.50	88.70	59.2701	3.8630
Shuttle Run Score	777	.00	100.00	56.5933	16.0204
Basketball Throw Raw(feet)	777	30.00	99.00	67.0952	12.0607
Basketball Throw Score	777	.00	100.00	54.2299	17.8267
Armstrength Raw(repetitions/seconds)	777	.00	47.00	10.2162	5.0637
Armstrength Score	777	.00	100.00	53.0533	16.1103
PAE Overall Score	777	101.04	377.23	225.3084	46.6749
Valid N (listwise)	777				

Tables C-4, C-5, and C-6 show data for the Female Predicted data set including minimum, maximum and mean scores. This data was used to test the model derived in Chapter 5.

Table C-4: Female PREDICTED Morphological Data

Morphological Data Characterization for Female PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years on July 1 of Plebe Yr	164	16.96	18.99	17.9839	.4148
height(inches)	157	60.00	75.00	65.8662	2.8580
Weight(pounds)	148	103	202	139.02	18.56
Body Fat Percentage	153	13	35	24.62	4.78
Body Mass Index	148	18.25	27.43	22.5053	2.2670
Valid N (listwise)	144				

Table C-5: Female PREDICTED Raw PRT Data

Raw PRT Data for Female PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Pushups (number)	154	18	101	50.24	17.12
Curlups (number)	154	51	135	84.71	14.43
PRT Run Time (minutes)	154	8.82	12.67	10.6957	.9196
PRT score (overall)	144	55.00	99.50	82.5681	9.7080
Valid N (listwise)	144				

Table C-6: Female PREDICTED Raw and Scaled PAE Data

Raw and Scaled PAE Data for Female PREDICTED

	N	Minimum	Maximum	Mean	Std. Deviation
Longjump Raw (inches)	163	58	94	76.60	7.26
Longjump Score	163	21.43	100.00	67.4244	19.4833
Shuttle Run Raw(seconds)	163	54.00	88.70	67.3104	5.1348
Shuttle Run Score	163	15.38	100.00	69.8765	16.6590
Basketball Throw Raw(feet)	163	23.00	72.00	40.1233	9.4976
Basketball Throw Score	163	12.50	100.00	55.9571	16.7619
Armstrength Raw(repetitions/seconds)	163	3.70	71.00	27.4139	14.6463
Armstrength Score	163	25.00	100.00	56.0972	19.7225
PAE Overall Score	163	142.85	393.33	249.6190	49.6372
Valid N (listwise)	163				

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LIST OF REFERENCES

Annapolis: the United States Naval Academy catalog 1970-1971. (1970). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1971-1972. (1971). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1974-1975. (1974). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1975-1976. (1975). Annapolis, MD.

Baldi, K.A. (1991). An overview of physical fitness of female cadets at the military academies. Military Medicine 156,(10), 537-9.

Bennett, J.D. (1989). The combat fitness test: its Victorian origins. Journal of the Royal Army Medical Corps 135,(2), 91-92.

Bowman, W.R. (1998). Dichotomous dependent variables and regression analysis using SPSS. Annapolis, MD: United States Naval Academy.

Bureau of Naval Personnel Home Page, NAVADMIN 063/00, (2000). World Wide Web address:http://www.persnet.navy.mil/navadmin/nav00/nav00063a.txt

Burger, S.C., et al. (1990). Assessment of the 2.4 km run as a predictor of aerobic capacity. South African Medical Journal, 78(6), 327-9.

Carver, R.P., et al. (1968). Analysis of the army physical proficiency test in terms of the Fleishman basic fitness tests. Perceptive Motor Skills, 26(1), 203-8.

Commandant midshipmen instruction 5400.5A. Revision date 20 July 1994.

Commandant midshipmen instruction 6110.2A.

Daniels, W.L. (1979). Physiological effects of a military training program on male and female cadets. Aviation, Space, and Environmental Medicine, 50(6), 562-6.

Daniels, W.L., et al. (1982). The effect of two years' training on aerobic power and muscle strength. Aviation, Space, and Environmental Medicine, 53(2), 117-21.

Deuster, P.A. (1987). Health and fitness profiles of male military officers. Military Medicine, 152(6), 290-3.

Harger, B. & Ellis, R. (1975). Circulo-respiratory fitness of United States air force academy cadets. Aviation, Space, and Environmental Medicine, 46(9), 1144-46.

Knapik, J.J. (1980). The influence of U.S. army basic initial entry training on the muscular strength of men and women. Aviation, Space, and Environmental Medicine, 51 (10), 1086-90.

Knapik, J.J. (1989). The army physical fitness test (APFT): a review of the literature. Military Medicine, 154 (6), 326-9.

Knapik, J.J. (1992). Validity of self-assessed physical fitness. American Journal of Preventive Medicine,8(6), 367-72.

Marcinik, E.J., et al. (1985). Aerobic/calisthenic and aerobic circuit weight training programs for navy men: a comparative study. Medical Science and Sports Exercise, 17 (4), 482-7.

Marcinik, E.J., et al. (1995). The relationship between the U.S. navy fleet diver physical screening test and job task performance. Aviation, Space, and Environmental Medicine, 66(4), 320-4.

McArdle, W.D., Katch, F.I., & Katch, V.L., (1981). Exercise physiology. Philadelphia, PA: Lea and Febiger.

Measuring and scoring physical aptitude for the United States naval academy. (1997). Washington D.C.: United States Government Printing Office.

Protzmann, R.R. (1979). Physiologic performance of women compared to men: observation of cadets at the United States military academy. American Journal of Sports Medicine,7(3), 191-4.

Regulations governing the admission of candidates into the United States naval academy and sample examination paper. (1936). Washington D.C.: United States Government Printing Office.

Regulations governing the admission of candidates into the United States naval academy and sample examination paper. (1951). Washington D.C.: United States Government Printing Office.

Regulations governing the admission of candidates into the United States naval academy and sample examination Paper. (1952). Washington D.C.: United States Government Printing Office.

Regulations governing the admission of candidates into the United States naval academy as midshipmen. (1963). Washington D.C.: United States Government Printing Office.

Sharp, J.R. (1991). The new air force fitness test: a field trial assessing effectiveness and safety. Military Medicine,156(4), 181-5.

Slack, M.C., et al. (1985). Per cent body fat alone is a poor predictor of physical fitness. Military Medicine, 150(4), 211-4.

Smith, D.J., et al. (1988). A simple test for the assessment of aerobic fitness. Journal of Royal Navy Medical Service, 74(2), 107-14.

Snoddy, R.O., et al. (1994). Predictors of basic infantry success. Military Medicine,159(9), 616-22.

Stevenson, J.M., et al. (1992). Development of physical fitness standards for Canadian armed forces younger personnel. Canadian Journal of Sports Science,17(3), 214-21.

Studenmund, A.H. (1997). Using econometrics (3rd ed.). Reading, MA: Addison Wesley.

Trent, L.K., et al. (1998). Longitudinal trends and gender differences in physical fitness and lifestyle factors in career U.S. navy personnel (1983-1994). Military Medicine,163(6), 398-407.

United States Naval Academy home page, (2000). World Wide Web address: **http://www.usna.edu/VirtualTour/150years**.

United States Naval Academy instruction 1531.51A., (1994).

University of Western Australia home page, (1999). World Wide Web Address: **http://www.general.uwa.edu.au/u/rjwood/me.htm.**

Welles, G. (1867). Extract from regulations governing the admissions of candidates into the naval academy. Annapolis, MD.

Williford, H.N., et al. (1994). The prediction of fitness levels of United States air force officers: validation of cycle ergometry. Military Medicine,159(3), 175-8.

Women Midshipmen Study Group. (1987). Report to the superintendent on the integration of women in the brigade of midshipmen. Annapolis, MD: United States Naval Academy.

Woodhead, A.B., et al. (1994). The effect of aviation officer candidate's school on aerobic and anaerobic fitness. Military Medicine,159(2), 118-20.

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BIBLIOGRAPHY

Annapolis: the United States Naval Academy catalog 1970-1971. (1970). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1971-1972. (1971). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1974-1975. (1974). Annapolis, MD.

Annapolis: the United States Naval Academy catalog 1975-1976. (1975). Annapolis, MD.

Baldi, K.A. (1991). An overview of physical fitness of female cadets at the military academies. *Military Medicine*, 156(10), 537-9.

Bennett, J.D. (1989). The combat fitness test: its Victorian origins. *Journal of the Royal Army Medical Corps*, 135(2), 91-92.

Berth-Jones, J. (1988). Step testing as an assessment of physical fitness on polaris submarines. *Journal of the Royal Navy Medical Service*, 74(2), 115-20.

Bowman, W.R. (1998). *Dichotomous dependent variables and regression analysis using SPSS.* Annapolis, MD: United States Naval Academy.

Bureau of Naval Personnel Home Page, (2000). World Wide Web address: http://www.persnet.navy.mil/navadmin/nav00/nav00063a.txt.

Burger, S.C., et al. (1990). Assessment of the 2.4 km run as a predictor of aerobic capacity. *South African Medical Journal,* 78(6), 327-9.

Carver, R.P., et al. (1968). Analysis of the army physical proficiency test in terms of the Fleishman basic fitness tests. *Perceptive Motor Skills*, 26(1), 203-8.

Celentano, E.J. (1984). The relationship between size, strength, and task demands. *Ergonomics*, 27(5), 481-8.

Choplin, N.T. (1999). Physical standards and military service. *Ophthalmology,* 106(2), 209-210.

Commandant Midshipmen Instruction 5400.5A. Revision date 20 July 1994.

Commandant Midshipmen Instruction 6110.2A.

Cooper, K.H. (1971). Physical fitness in United States and Austrian military personnel: a comparative study. *Journal of American Medical Association*, 215(6), 931-4.

Daniels, W.L. (1979). Physiological effects of a military training program on male and female cadets. *Aviation, Space, and Environmental Medicine*, 50(6), 562-6.

Daniels, W.L., et al. (1982). The effect of two years' training on aerobic power and muscle strength. *Aviation, Space, and Environmental Medicine*, 53(2), 117-21.

Deuster, P.A. (1987). Health and fitness profiles of male military officers. *Military Medicine,* 152(6), 290-3.

Harger, B.S., & Ellis, R. (1975). Circulo-respiratory fitness in United States air force academy cadets. *Aviation, Space, and Environmental Medicine,* 46(9), 1144-6.

Harwood, G.E. (1999). Fitness, performance, and risk of injury in British army officer cadets. *Military Medicine,* 164(6), 428-34.

Kilpatrick, W.G. (1989). Selection of soldiers: physical build as an entry factor. *Journal of the Royal Army Medical Corps,* 135(2), 95-6.

Knapik, J.J. (1980). The influence of U.S. army basic initial entry training on the muscular strength of men and women. *Aviation, Space, and Environmental Medicine,* 51(10), 1086-90.

Knapik, J.J. (1989). The army physical fitness test (APFT): a review of the literature. *Military Medicine,* 154(6), 326-9.

Knapik, J.J. (1992). Validity of self-assessed physical fitness. *American Journal of Preventive Medicine,* 8(6), 367-72.

Legg, S.J. (1996). The effects of basic training on aerobic fitness and muscular strength and endurance of British army recruits. *Ergonomics,* 39(12), 1403-18.

Marcinik, E.J., et al. (1985). Aerobic/calisthenic and aerobic circuit weight training programs for navy men: a comparative study. *Medical Science and Sports Exercise,* 17(4), 482-7.

Marcinik, E.J., et al. (1995). The relationship between the U.S. navy fleet diver physical screening test and job task performance. *Aviation, Space, and Environmental Medicine,* 66(4), 320-4.

McArdle, W.D., Katch, F.I., & Katch, V.L., (1981). *Exercise physiology.* Philadelphia, PA: Lea & Febiger.

McDonald, D.G.(1990). Training success in U.S. navy special forces. *Aviation, Space, and Environmental Medicine,* 61(6), 548-54.

Measuring and scoring physical aptitude for the United States Naval Academy. (1997). Washington, DC: United States Government Printing Office.

Perry, M.E. (1992). The effect of intermediate altitude on the army physical fitness test. *Military Medicine,* 157(10), 523-6.

Protzmann, R.R. (1979). Physiologic performance of women compared to men: observations cadets at the United States military academy. *American Journal of Sports Medicine,* 7(3), 191-4.

Regulations governing the admission of candidates into the United States Naval Academy and sample examination paper. (1936). Washington, DC: United States Government Printing Office.

Regulations governing the admission of candidates into the United States Naval Academy and sample examination paper. (1951). Washington, DC: United States Government Printing Office.

Regulations governing the admission of candidates into the United States Naval Academy and sample examination paper. (1952). Washington, DC: United States Government Printing Office.

Regulations governing the admission of candidates into the United States Naval Academy as midshipmen. (1963). Washington, DC: United States Government Printing Office.

Sharp, J.R. (1991). The new air force fitness test: a field trial assessing effectiveness and safety. *Military Medicine,* 156(4), 181-5.

Slack, M.C., et al. (1985). Per cent body fat alone is a poor predictor of physical fitness. *Military Medicine*, 150(4), 211-4.

Smith, D.J., et al. (1988). A simple test for the assessment of aerobic fitness. *Journal of Royal Navy Medical Service,* 74(2), 107-14.

Snoddy, R.O., et al. (1994). Predictors of basic infantry success. *Military Medicine,* 159(9), 616-22.

Stevenson, J.M., et al. (1992). Development of physical fitness standards for Canadian armed forces younger personnel. *Canadian Journal of Sports Science,* 17(3), 214-21.

Studenmund, A.H. (1997). *Using econometrics (3^{rd} ed.).* Reading, MA: Addison Wesley.

Thompson, B. (1994). The concept of statistical significance. World Wide Web address: http://www.ericae.net/pare/getvn.asp?v=4&n=5.

Trent, L.K., et al. (1998). Longitudinal trends and gender differences in physical fitness and lifestyle factors in career U.S. navy personnel (1983-1994). *Military Medicine,* 163(6), 398-407.

United States Naval Academy home page, (2000). World Wide Web address: **http://www.usna.edu/VirtualTour/150years**.

United States Naval Academy instruction 1531.51A., (1994).

University of Western Australia home page, (1999). World Wide Web Address: **http://www.general.uwa.edu.au/u/rjwood/me.htm**.

Welles, G. (1867). *Extract from regulations governing the admissions of candidates into the naval academy.* Annapolis, MD.

Williams, A.G. (1999). Effects of basic training on material handling ability and physical fitness of British army recruits. *Ergonomics,* 49(8), 1114-24.

Williford, H.N., et al. (1994). The prediction of fitness levels of United States air force officers: validation of cycle ergometry. *Military Medicine,* 159(3), 175-8.

Women Midshipmen Study Group. (1987). *Report to the superintendent on the integration of women in the brigade of midshipmen.* Annapolis, MD: United States Naval Academy.

Women Midshipmen Study Group. (1990). *Report to the superintendent on the assimilation of women in the brigade of midshipmen.* Annapolis, MD: United States Naval Academy.

Woodhead, A.B., et al. (1994). The effect of aviation officer candidate's school on aerobic and anaerobic fitness. *Military Medicine,* 159(2), 118-20.

Woodruff, S.I. (1992). An assessment of pre- and post-fitness measures in two remedial conditioning programs. *Military Medicine,* 157(1), 25-30.

Woodruff, S.I. (1992). A longitudinal assessment of the impact of health/fitness status and health behavior on perceived quality of life. *Perceptive Motor Skills,* 75(1), 3-14.

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